U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1767

Training and Assessment of Decision-Making Skills in Virtual Environments

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14. ABSTRACT *(Maximum 200 words)*:

This report describes a preliminary research effort to: 1) determine the effectiveness of using a virtual environment to train real world decision-making skills; 2) examine the feasibility of using a virtual environment as a test bed for developing situation awareness (SA) measurement instruments and; 3) empirically assess the role of SA in decision-making in simulated dismounted infantry environments. Seven experienced and seven inexperienced officers, role-playing a dismounted infantry platoon leader, individually conducted four urban operation scenarios (missions) in a virtual environment setting. Decision-making capability and SA were assessed for each mission. Objective decision-point accuracy improved significantly over missions. Level of experience did not impact the rate of learning. Experience did play a significant role in SA assessments. Selected SA measures also predicted a significant portion of the variance in objective decision-point scores. The research showed that real world decision-making skills could be trained using virtual environment technologies. To insure maximum benefit, virtual training must be combined with the appropriate field experience and mentoring. Conducting research in a controlled virtual environment setting permitted closer empirical scrutiny of the linkage between decision-making and SA in dismounted infantry operations and suggested new directions for further work in these areas.

15. SUBJECT TERMS

Decision-making; Situation awareness (SA); Individual combatant simulators; Small unit leader training; Virtual environment; Urban operations; Dismounted infantry simulation

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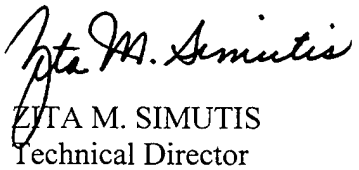
Personnel Performance and Training Technology

FOREWORD

This report describes selected aspects of the second year work effort under the Science and Technology Objective (STO) entitled *Virtual Environments for Dismounted Soldier Simulation, Training, and Mission Rehearsal*. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Infantry Forces Research Unit performed this research in collaboration with the ARI Simulation Systems Research Unit, the U.S. Army Simulation, Training, and Instrumentation Command, and the U.S. Army Research Laboratory. The primary objective of the STO was to address selected technological and training issues related to high fidelity dismounted soldier simulation.

This report describes a preliminary research effort that examined the utility of virtual environments for training small unit dismounted infantry leader (platoon level) decision-making skills in simulated urban operations. The training was evaluated at the Dismounted Battlespace Battle Lab (DBBL) Land Warrior Test Bed, Fort Benning, Georgia. The research identifies possible solutions for enhancing virtual environment decision skills training. By incorporating virtual environment technologies in training, soldiers are able to develop the cognitive framework needed for effective decision-making at reduced cost to the unit in training time and/or actual expense. Critical aspects of the research were briefed to all key STO participants including the Chief of the DBBL Simulation Center, at separate STO meetings on 2 March, 22 June, and 14 November 2000.



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TRAINING AND ASSESSMENT OF DECISION-MAKING SKILLS IN VIRTUAL ENVIRONMENTS

EXECUTIVE SUMMARY

Research Requirements:

Small unit leaders (platoon, squad, team) must be capable of taking effective independent actions across an increasingly diverse range of military missions. They must be prepared to deal with a complex urban-oriented battlefield that could change in scope and lethality without warning. Critical to the unit's success is the leader's ability to recognize environmental cues and relevant situational factors, maintain situation awareness (SA), apply appropriate strategies, and make effective real-time decisions. Conducting the appropriate cognitive skills training at real-world urban training sites can be extremely costly. One solution is to conduct a portion of this training in virtual environments through the use of individual combatant simulators. The present research combined both basic and applied research objectives. The primary objectives were:

- Determine the effectiveness of using a virtual environment to train real world decision-making skills.
- Determine the feasibility of using a virtual environment as a test bed for developing SA measurement instruments.
- Empirically assess the role of SA in decision-making in simulated dismounted infantry environments.

Procedure:

Seven experienced and seven inexperienced officers, role-playing a dismounted infantry platoon leader, individually conducted four urban operation scenarios (missions) in a virtual environment setting. Scenarios included built-in decision points that required the officer to take specific actions at each point. Decision-making capability and SA were assessed for each mission. In addition, soldier responses to the training and the simulation systems were obtained at the conclusion of the experiment.

Findings:

Objective decision-point accuracy improved significantly over missions. The officers' level of experience did not impact the rate of learning. Experience did play a significant role in SA assessments. Selected SA measures also predicted a significant portion of the variance in objective decision-point scores. Overall, the officers felt that their decision-making skills had improved as a result of the training they received and that decision-making skills could be effectively taught using virtual environment technologies. Virtual decision-skills training was

viewed as particularly effective for the inexperienced lieutenant during the "walk" phase of training.

Utilization of Findings:

The research showed that real world decision-making skills could be trained using virtual environment technologies. To insure maximum benefit, virtual training must be combined with the appropriate field experience and mentoring. The virtual environment can also serve as an effective test bed (medium) for conducting both basic and applied research in decision-making and SA. Conducting research in a controlled virtual environment setting permitted closer empirical scrutiny of the linkage between decision-making and SA in dismounted infantry operations and suggested new directions for further work in these areas.

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Introduction

Preparing small unit leaders (platoon, squad, and team) for future warfare will present many challenges to trainers. Leaders must be capable of taking effective independent actions across an increasingly diverse range of military missions including humanitarian assistance, peacekeeping, peace enforcement, and low or high intensity conflict as part of a joint, combined, or interagency operation (TRADOC PAM 525-66, 2001). The small unit leader must be prepared to deal with a complex battlefield that could change in scope and lethality without warning.

Many of these missions will likely take place in urban settings. Conducting the requisite training at existing real-world urban training sites can be very expensive and inefficient in terms of the specific leader skills needed for such operations. The small unit leader operating in an urban environment has a cognitively challenging job. He must make quick decisions in a complex, uncertain, and very fluid environment.

Conducting missions in urbanized terrain puts enormous demands on a leader's situation awareness (SA). The complexities of the urban environment including the three dimensional, non-linear aspects of the urban area, a poorly defined enemy, an unpredictable and volatile civilian presence, and restrictive rules of engagement make it difficult to sustain high levels of SA. Such environments require that the small unit leader attend to multiple data sources, prioritize among competing and sometimes conflicting goals, and make rapid decisions, all under highly stressful conditions (Strater, Endsley, Pleban, & Matthews, 2001).

Critical to the unit's success is the leader's ability to recognize environmental cues and relevant situational factors, maintain situation awareness, apply appropriate strategies, and make effective real-time decisions. Adequate preparation for such missions would require exposing the small unit leader to multiple scenarios, providing sufficient practice, and timely feedback so he can effectively assimilate the many lessons learned from the training.

Clearly, following such an approach in a real-world urban training site would be very costly. One solution is to conduct a portion of this training in virtual environments (VE) through the use of individual combatant simulators.

At the Dismounted Battlespace Battle Lab (DBBL) Land Warrior Test Bed (LWTB) at Fort Benning, Georgia, for example, the individual soldier or small unit leader can explore innovative approaches for conducting urban operations and mission rehearsal activities in virtual settings. Through the use of individual combatant simulators, soldiers can immerse themselves in virtual representations (data bases) of urban training sites such as the McKenna site at Fort Benning, and conduct limited missions (e.g., clear a building, conduct area reconnaissance). Virtual environments, in

theory, offer soldiers the opportunity to thoroughly rehearse missions to familiarize themselves with the procedural aspects of specific tasks as well as offering a chance to examine new tactics and techniques. These simulators allow the soldiers to play out scenarios and determine the impact of various courses of action on the likely success of a mission (Pleban, Eakin, & Salter, 2000).

One of the best performing of the currently existing individual combatant simulation systems is a prototype version of the Soldier Visualization Station (see Salter, Eakin, and Knerr, 1999) developed by Reality by Design (RBD). This system represents the currently most viable overall technical approach for enabling soldiers to shoot, move, and communicate in virtual environments. In this system, the soldier stands in front of a large screen holding a rifle. The images depicted on the screen, including buildings, vehicles, and people are reasonably life-like in size and actions. The combination of images and action creates a very immersive (virtual) environment for the soldier.

The SVS is a PC (Pentium) based system with an inertial/acoustic tracker for simulated body position and weapon pointing. It includes an integrated head assembly subsystem (helmet mounted display - HMD) that can be used to assist in aiming and looking around corners of buildings. The SVS has one flat screen on which images are presented by a rear projection device. Movement is accomplished by applying pressure to a weapon-mounted thumbstick. This allows the individual to move rather effortlessly throughout the virtual battlefield to include open terrain and urban environments.

Science and Technology Objective (STO) Virtual Environment Research

The U. S. Army Research Institute (ARI) recently established a four year Science and Technology Objective (STO) entitled Virtual Environments for Dismounted Soldier Simulation Training and Mission Rehearsal (1998). The purpose of the STO is to examine selected technological and training issues that currently limit high fidelity dismounted simulation (see Pleban, Eakin, and Salter, 2000, for a complete listing of STO issues).

A collaborative STO effort was established between the Infantry Forces and Simulation Systems Research Units of ARI, the U.S. Army Simulation, Training, and Instrumentation Command, and the Human Research and Engineering and Information Sciences and Technology Directorates of the U.S. Army Research Laboratory to address theses issues. The ARI portion of the STO is covered under the work package Virtual Environment Research for Infantry Training and Simulation (VERITAS). Key VERITAS work objectives include the following:

- Identify potential high-payoff tasks for small unit leader VE training
- Evaluate small unit training vignettes for use in infantry MOUT training
- Develop training strategies and performance measures
- Evaluate the training effectiveness of simulation systems

VERITAS: FY 99 Research

Pleban et al. (2000) addressed the first two objectives (*Identify potential high-payoff tasks* and *Evaluate small unit training vignettes*) in separate investigations. Pleban et al. developed five small unit dismounted infantry scenarios based on the tasks Assault, Move Tactically, Enter Building/Clear a Room, Reconnoiter Area, and React to Contact. Fire team and squad level missions were conducted in a virtual urban environment setting modeled after the McKenna training area. A similar set of scenarios was run at the actual McKenna training site. Overall, the simulators were seen as effective for small unit training. Although the data were based on subjective reports, the soldiers indicated that the simulations had improved their real-world performance on similar tasks conducted at the McKenna training site.

While the results were promising, the focus in this study was very basic, i.e., could soldiers perform key dismounted infantry tasks in a virtual environment? The results indicated that, for the most part, they could. Soldiers also listed a number of ways these simulators could be effectively used for small unit training. Potential training applications include:

- Training small team coordination/communication skills
- Mission rehearsal
- Developing and assessing alternative courses of action
- Developing and refining small unit leader decision-making skills

VERITAS: FY 00 Research

Year two leveraged the findings from the previous research to address the last two VERITAS objectives (*Develop training strategies and performance measures* and *Evaluate training effectiveness of simulation systems*). The overall focus of this research effort was to investigate the potential of the SVS as a decision skills trainer. The earlier research by Pleban et al. (2000) showed that the SVS system could be used to train certain aspects of room clearing, for example. However, to use the system as a decision skills trainer would require more complex scenarios and an effective performance assessment/feedback system. More importantly, a training strategy is needed that effectively integrates and reinforces the skills required for making quick, accurate decisions under high stress conditions.

A Situational-Based Model of Decision-Making

Research presented by Klein (1997) indicated that in naturalistic settings characterized by uncertain dynamic environments, shifting or competing objectives, time constraints, and high stakes, greater training value can be obtained by helping people to quickly size up situations confronting them by improving their proficiency in recognizing cues and patterns. Earlier observations by Klein (as cited in Drillings and Serfaty, 1997) revealed that decision-makers in difficult situations and under time pressure did not appear to use the classical approach to decision making (generate options and directly

compare the alternatives to make decisions), even when they were trained in that approach. Klein's observations led him to hypothesize that decision-making in real world environments revolves around trying to understand the situation and judging its familiarity (to other situations).

Naturalistic versus classical approaches to decision-making. The naturalistic approach to decision-making stands in direct contrast to classical, context-free rational choice strategies. Under the classical approach, a range of options are generated, evaluation criteria are identified, each option for each criterion is evaluated, results are calculated and the option with the highest score is selected. The classical approaches to decision-making focus on application. They try to improve process regardless of content area. While useful in some situations where time pressure is low and the problem is stable, the context-free strategies do not provide an optimal means for improving decision-making skills in naturalistic real-world environments [see Means, Salas, Crandall and Jacobs (as cited in Klein, 1997)]. Klein (1997) argues that this approach may be ineffective because it tries to accommodate all situations, but does not fit any specific situation very well.

To be successful in the complex battlefield of the future, the small unit leader must become more proficient in making rapid, accurate assessments of the decision situation and he must be able to make these decisions under varying levels of uncertainty and severe time constraints. This will place a premium on the leader's ability to simultaneously read and assess the significance of various situational and tactical cues and to efficiently manage the timing of decisions/mission events (Cannon-Bowers & Bell, 1997; Klein, 1997).

The Role of Situation Awareness (SA) in Naturalistic Decision-Making

Additional research [Drefus; Klein; Klein, Calderwood, & Clinton-Cirocco (as cited in Endsley, 1997)] supports Klein's earliest observations. Specifically, under realistic conditions, experts make decisions utilizing a holistic process involving situation recognition and pattern matching to mental schemas of the situation to make rapid decisions. Within this model, a person's situation awareness, an internal conceptualization of the present situation, becomes the driving factor in the decision-making process (Endsley, 1997).

Situation awareness refers to the cognitive processes involved in perceiving and comprehending the meaning of a given stimulus environment, that leads to sound, timely decisions regarding likely future events in that environment (Endsley, 1997). Situation awareness is a process that involves: 1) the perception of the elements in a particular environment; 2) understanding the meaning of those elements and; 3) the ability to translate perception and understanding of the environment into a projection of future events likely to occur in that environment. The concept of SA has been rigorously applied in the field of aviation and other technologically advanced systems where the individual must perceive and comprehend large amounts of information in short periods of time and make important decisions based on those processes. Breakdowns in the SA

process have been related to various aviation and other accidents (e.g., Hartel, Smith, & Prince, 1991).

According to Endsley (1997), many human errors that are attributed to poor decision-making usually involve problems with the SA portion of the decision-making process. People make the correct decision based on their perception of the situation, but that perception is in error. In realistic settings, the major task facing the decision-maker is establishing an ongoing awareness and understanding of the key situational components. Situation awareness provides the primary input to the decision process and plays a significant role in shaping the decision strategy selected.

The Problem of Measuring SA in Dismounted Infantry Environments

Despite the key role of SA in naturalistic decision-making and infantry operations, relatively little formal consideration has been given to its role in battlefield success. Several factors have limited the application of SA in infantry training/ operations. First, a valid set of metrics tailored to assess SA in dismounted infantry operations has not yet been developed. Second, until recently, there has been no satisfactory setting where core SA measurement methodologies such as the Situation Awareness Global Assessment Technique-SAGAT (Endsley, 1988; 1995) could be administered to assess dismounted infantry SA.

The SAGAT procedure involves stopping exercises or simulations at random points and asking probe questions aimed at evaluating a participant's SA. The probe questions focus on all three levels of SA described earlier – perception, understanding, and projection of future events. The participant's SAGAT responses are then compared to some source of "ground truth". This requires another observer to verify what constitutes "correct" answers to the SAGAT probes. The end result of this comparison process is an objective indication of the participant's level of SA.

Using Virtual Environments for Decision-Making/SA Research and Training

Research. The availability of the LWTB provides an ideal setting for both the administration of the SAGAT and the development of SA measurement instruments that can be used by trainers and researchers. The virtual environment setting allows for greater control of both extraneous and experimental variables than would be possible in a real world training site. Using the SAGAT process in a controlled setting such as the LWTB can provide the objective baseline data needed to validate new SA measurement instruments. This type of setting provides, for the first time, a unique opportunity to conduct basic and applied research linking SA to decision-making in simulated dismounted infantry environments.

Training. Simulations can play a key role in training naturalistic decision-making skills [Means, Salas, Crandall, & Jacobs (as cited in Cannon-Bowers and Bell, 1997)] and possibly refining individual SA capabilities as well. Simulations can accelerate proficiency by exposing the small unit leader to the kinds of situations he is likely to

confront in the real world. More importantly, a simulation can be controlled. The characteristics of the decision problem portrayed in a mission scenario can be shaped to address specific teaching points based on trainer input. Specific situational cues and cue patterns from various sources (e.g., audio communications from squad leaders and the company commander, terrain and building characteristics, presence of civilians, enemy, aircraft, heavy weapons) can be incorporated in the scenarios. In addition, time constraints can be played in the scenarios, forcing the small unit leader to make quick situational assessments and decisions under stress.

To maximize the training value of the scenarios, timely (and relevant) feedback must be provided. Research reported by Cannon-Bowers and Bell (1997) indicated that allowing trainees to practice on a task without feedback may produce suboptimal decision-making performance. In the present context, feedback means reinforcing the important cue-action/strategy associations identified in the scenarios. This feedback is critical for helping the leader characterize cue patterns and build templates (mental models) that will enable him to make the correct associations between cues or cue patterns and appropriate actions.

Increasing exposure to varied scenarios, combined with the structured feedback described above, should enhance the leader's ability to accurately characterize situations and lead to greater situational understanding. This, in turn, should lead to improved decision-making capability.

Specific Research Objectives.

The close linkage between Klein's (1997) naturalistic decision-making model and situation awareness concepts (Endsley, 1997) suggested the two areas could be addressed under a single comprehensive research effort having both basic and applied objectives. The primary objectives of the present research were:

1) Determine the effectiveness of using a virtual environment (LWTB) to train real world decision-making skills.

2) Determine the feasibility of using a virtual environment as a test bed for developing SA measurement instruments.

3) Empirically assess the role of SA in decision-making in simulated dismounted infantry environments.

Method

Overview

Experienced and inexperienced officers were put in an immersive virtual environment and given four scenarios (missions) to execute. Scenarios included built-in decision points that required the officer to take specific actions at each point. The objectives were to determine: 1) if decision-making improved over repeated trials and 2) the role of experience in facilitating the rate of learning.

The experiment included both within factor (trials) and between factor (experience) variables. The experimental design required one subject per day, alternating lieutenants and captains. The subject, role-playing a dismounted infantry platoon leader, conducted four virtual urban operation missions. Missions for trials one and four switched each day. Missions for trials two and three remained the same throughout the experiment. Three retired military officers/non-commissioned officers played the roles of the platoon sergeant and the squad leaders. An infantry major role-played the company commander. Another infantry major served as an observer. A retired infantry officer served as the observer/controller (O/C). The O/C's role was to observe the subject, offer guidance during the scenario (as needed), provide immediate feedback following the completion of each scenario, and make assessments related to the subject's leader/decision-making capability and level of situation awareness. An ARI researcher served as an observer and data collector.

The sequencing and administration of the data collection instruments during the experiment is summarized in Table 1. For example, each subject completed four instruments – Biographical Information Questionnaire, SAGAT in trials 2 and 3, self-ratings of SA after each trial, and the Post-Experiment Questionnaire. The squad leaders completed the Execution Scale after each trial. The actual instruments are described later.

Subjects

Subjects were 14 male officers from Fort Benning, Georgia. One of the officers was Armor; the other 13 were Infantry. The average age of the seven lieutenants was 23 years, 8 months. For the captains, the average age was 27 years, 10 months. Time in service ranged from 11 - 83 months for the lieutenants and from 49 – 133 months for the captains. All officers were Airborne qualified and four of the seven officers from each group had successfully completed Ranger school.

Six of the lieutenants and three of the captains had trained at the McKenna MOUT (Military Operations on Urban Terrain) site at Fort Benning from one to three times since basic training. Only one officer had ever operated a virtual individual combatant simulator such as the type employed at the LWTB. However, almost all had some experience with military simulation systems such as JANUS, Simulation Networking (SIMNET), and the Close Combat Tactical Trainer.

Table 1

Data Collection Instruments Used in the Experiment

Instrument	Test Subject	Observer Controller	Company Commander	Squad Leaders	ARI Observer
Biographical Information Q	Training				
Adequacy of the Plan Scale		Trials 1,2,3,4			
Appropriate Level of Initiative Scale		Trials 1,2,3,4			
Plan's Fit w/ Cdr's Intent Scale		Trials 1,2,3,4			
Leader's Rationale Scale			Trials 1,2,3,4		
Mission Performance Scale			Trials 1,2,3,4		
Execution Scale				Trials 1,2,3,4	
SABARS		Trials 1,2,3,4			
SAGAT	Trials 2, 3		Trials 2,3		
PSAQ	Trials 1,2,3,4				
Post-Exp. Q	Debrief				
Object. Decision-point Responses					Trials 1,2,3,4

Note. SABARS - Situation Awareness Behaviorally Anchored Rating Scale;
SAGAT - Situation Awareness Global Assessment Technique;
PSAQ - Post-Trial Participant Subjective SA Questionnaire.

Instruments

Biographical Information Questionnaire. The Biographical Information Questionnaire (Appendix A) is a multiple choice/short answer paper-and-pencil instrument designed to document the prior military training and experience of each subject, as well as their experience with computers and simulations.

Observer/Controller (O/C) Decision-Making/Leadership Rating Instruments. As part of the experiment, each subject was required to develop a plan. The *Adequacy of the Plan (Adequacy) Scale* (Appendix B) consists of 10 yes-no items that address various aspects of the subject's (platoon leader's) plan. Areas included, for example, level of detail, feasibility of approach, and ease of understanding. One global assessment item was included. It used a five-point scale with anchor points "Very Good", "Good", "Borderline", "Poor", and "Very Poor". (All global assessment items for the scales described below used the same five-point scale.) The *Adequacy Scale* was completed by the O/C after the subject had briefed his plan to the squad leaders.

The *Appropriate Level of Initiative (Initiative) Scale* (Appendix C) consists of eight yes-no questions designed to assess the level of initiative demonstrated by the subject during the scenario. Items addressed the timeliness of decisions, appropriateness of actions for the situation, ability to improvise within the commander's intent, and the ability to work effectively in fluid environments. The O/C also provided a global assessment of initiative.

The *Plan's Fit within Commander's Intent (Intent) Scale* (Appendix D) was formatted similarly to the previous two instruments. This scale consists of three yes-no items and one global assessment rating. The scale was designed to assess the subject's ability to tailor his plan within a larger unit plan. Areas addressed included actions based on the intent of higher command and consideration of other friendly units. Both the *Initiative* and *Intent Scales* were completed by the O/C at the conclusion of each exercise/scenario.

Company Commander Decision-Making/Leadership Rating Instruments. The infantry major role-playing the company commander completed two instruments following the completion of each scenario. The *Leader's Rationale Scale* (Appendix E) is composed of four yes-no questions and one global assessment rating. The scale was designed to assess the soundness of the subject's actions taken during the scenario (e.g., decisions were based on a reasonable assessment of the enemy; decisions demonstrated an understanding of the strengths and weaknesses of the situation). The *Mission Performance Scale* (Appendix F) was the company commander's assessment of the mission (e.g., was the mission accomplished?; was the mission accomplished in a timely fashion?). The scale consists of four yes-no items and one global assessment.

Squad Leaders' Decision-Making/Leadership Rating Instrument. The squad leaders filled out the *Execution Scale* (Appendix G) following the completion of each exercise scenario. The scale consisted of three yes-no items and one global assessment item. The focus of this scale was on the clarity of orders received from the test subject, and whether the orders adequately communicated unit objectives.

Situation Awareness Behaviorally Anchored Rating Scale (SABARS). Following the completion of each scenario, the O/C completed a SABARS rating form (Appendix H) for each subject. The SABARS (Matthews, Pleban, Endsley, & Strater, 2001) consists of 28 items designed to assess how (well) the subject acquires and disseminates information during the course of the scenario (from the O/C's perspective). The subject's SA was reflected in such items as "Uses assets to effectively assess environment"; "Communicates key information to commanding officer"; "Employs squads tactically to gather needed information"; and "Communicates to squads overall situation and commander's intent". Behaviors were rated on a five-point scale as "Very Poor", "Poor", "Borderline", "Good", or "Very Good". An additional response for "Not Applicable" was added for items (actions) that could not be assessed from the scenario.

Situation Awareness Global Assessment Technique (SAGAT). SAGAT items consisted of 21 questions relevant to infantry MOUT operations and aimed at assessing

the subject's level of SA at specific times over the course of the scenario. Questions focused on areas such as the location of friendly and enemy elements, strongest and weakest friendly locations, and projections of enemy and civilian actions. The SAGAT was presented to the subject on a lap top computer. The company commander completed a paper-and-pencil version of the same instrument. The company commander's responses provided the baseline "ground truth" from which the subject's responses were compared. The resulting comparison provides an indication of the subject's objective level of SA (Appendix I)

Post-Trial Participant Subjective SA Questionnaire (PSAQ). The PSAQ (Appendix J) is a three-item instrument designed to assess not only each subject's perceived level of SA during the scenario, but also work-load (How hard were you working during the scenario?) and quality of performance (How well did you perform during the scenario?). The PSAQ was administered at the conclusion of a scenario and each item was rated on a five-point scale. The SA item asks the subject to indicate how aware he was of the evolving situation during the scenario. Response categories range from "Not Aware of the Situation" to "Completely Aware of the Situation".

Post Experiment Questionnaire. The Post Experiment Questionnaire (Appendix K) was administered to each subject following the completion of all scenarios. The questionnaire is a multiple choice/short answer instrument developed to obtain specific information concerning:

- The training value of the scenarios
- The challenge/difficulty level of the scenarios
- What soldiers liked most/least about the training
- Suggestions for making the training more effective
- Whether the current training improved decision-making skills
- The feasibility of training decision-making skills in virtual environments
- The value of including virtual environment decision-making skills training in the Infantry Officer Basic Course curriculum

Responses to selected items were discussed in more detail during follow-up interviews with one of the ARI researchers.

Small Unit Leader Decision-Making Scenarios

All scenarios were set as if in a small European town. The town was a virtual representation of the McKenna MOUT training site. Military subject matter experts developed four scenarios that included: Stability and Security Operations (SASO), Company Assault, Defend, and Secure Village. Each scenario had from four to seven predetermined decision points. For each decision point, several leader actions were identified (e.g., discuss rules of engagement with squad leaders, send experienced squad to conduct patrol, report to company commander, send fragmentary order, determine injury status of soldiers/civilians). Appendixes L-O provide specific flow charts detailing the decision process for these scenarios.

Scenarios were designed to be cognitively challenging for the subjects. This was accomplished by imposing 1) severe time constraints, 2) high levels of uncertainty, and 3) multiple/rapid decision requirements. Specific teaching points were addressed in each scenario. Scenarios incorporated a number of events (e.g., presence of snipers, unruly civilian crowds, friendly and civilian fratricide, exposure to chemical agents, and weapon misfires to further complicate the scenario. These distracters were included to force each subject to prioritize events and stay focused on the larger mission at hand. The scenarios minimized the amount of platoon leader movement required. This was done to keep the run-times of scenarios to approximately 20-25 minutes and to maintain each subject's focus on the cognitive aspects of the mission.

The scenarios focused primarily around the interaction between the subject (platoon leader), his three squad leaders, the company commander and the platoon sergeant. Computer-generated avatars, Dismounted Infantry Semi-Automated Forces (DI-SAF) were employed to fill the individual squad member positions for each squad. In general, DI-SAF soldiers were used very sparingly in the scenarios. (One role player played the parts of two squad leaders.)

Apparatus

Soldier Visualization Station (SVS). Three full-immersion SVS systems (helmet mounted display - HMD, weapon, screen) were employed along with a desktop version. The desktop system was joystick controlled. The three stand-alone systems were linked to the desktop. Technical specifications of the two systems are shown in Table 2. Squad leaders could communicate with each other. Each subject (platoon leader) could communicate with the squad leaders, the platoon sergeant, and the company commander. Communication nets and procedures were similar, but not identical to what subjects would be accustomed to in a real world environment. The three SVS systems were housed in their own enclosures. These enclosures were made of thick black cloth and fastened to a metal frame surrounding the SVSs. They were designed to dampen extraneous sound, reduce light, and minimize distractions from other people moving around the area. One panel of cloth on the subject's enclosure was tied back to allow the O/C and the researcher to observe and record activities from the rear perimeter of the SVS.

Each test subject and squad leader operated an SVS, while the company commander operated the desktop system. The platoon sergeant observed events from either the DI-SAF operator's computer screen depicting a top-down view of McKenna or by looking at the company commander's screen. The company commander and DI-SAF operator systems were adjacent to each other, but away from the SVS systems.

Table 2

Technical Specifications of the Immersive SVS and Desktop SVS Simulation Systems

System Hardware (Immersive and Desktop)	• Pentium III – 450 MHz microprocessor • 128 Mb RAM • Obsidian 200 – 8440 3D Graphics Card • SoundBlaster AWE 64 Gold Audio Card • Removable 4.55 GB SCSI Hard Drive
Movement Control	• Weapon-mounted thumbswitch • Desktop SVS – Microsoft joystick control
Motion Capture/ Weapon Tracking	• InterSense Mark2 X-Bar Tracking System • Weapon tracking accurate to within ½ of 1°
Visual Display	• 90° x 60° FOV at center of enclosure (varies with position change) • Rear screen projection resolution 1024 x 768 • Desktop SVS resolution 800 x 600
Enclosures	• Aluminum frame over black sound-dampening fabric. (10 x 10 x 12)
Software	• Reality By Design proprietary software

Automated Performance Assessment System. The decision-point actions of the subject were recorded by one of the ARI researchers using a personal computer. A graphic user interface (GUI) board was created for each scenario that listed all leader actions (actually non-actions) by decision point. For example, decision-point 3 of the SASO scenario consisted of the following non-actions: "No SITREP to commander", "Fails to obtain status of WIA", and "Fails to provide instructions (to squads)". If the subject failed to engage in the appropriate action, the researcher, using a mouse, clicked on the specific activity listed on the GUI board. The entry was then recorded and time-stamped.

Procedure

Role player training. Training took place prior to the experiment and consisted of two parts. The first part lasted approximately three days and involved all of the role players and the GUI board operator. Several "dry runs" were conducted where the role players (squad leaders, platoon sergeant, and company commander) walked through the scenarios and familiarized themselves with the scripts and the timing of the verbal cues that they would provide the platoon leader to trigger his decision actions. Role players were also given time to familiarize themselves with the simulation systems. After the "dry runs" were completed a full rehearsal was conducted on the last day. An infantry officer, who would serve as an extra observer during the experiment, played the role of platoon leader. All four scenarios were run and decision-point data were collected. After the full rehearsal was conducted, any modifications that were needed from a procedural standpoint were completed.

Soldier training. Each subject arrived in the morning at the Land Warrior Test Bed and was briefed on the objectives of the experiment. He was given a chance to ask any questions concerning his role in the experiment. He then completed the Biographical Information Questionnaire.

After completing the questionnaire, the subject was familiarized with the SAGAT procedures. A technician was present to explain the SAGAT process and to answer any questions. The subject was then allowed to work through a SAGAT test run that was presented on a lap top computer. [SAGAT items were based on an extensive requirements analysis that focused on the execution of the Assault (Attack) and Defend (Secure and Hold) missions in a MOUT environment. A determination was made not to use these missions as either the pre or post-tests due to the possible performance cueing effects of the SAGAT procedure on decision-making scores.]

Following the SAGAT training, the subject was given a brief introduction to the SVS system and allowed hands-on time to familiarize himself with some of the key system features (e.g., moving within the SVS area, moving via the thumb switch on the M-4 rifle, engaging targets). In addition, he was shown what various entities looked like in the virtual world (e.g., buildings, furniture, friendly/enemy forces, civilians, vehicles, and aircraft).

Experimental procedure. Once the training phase was completed, the subject read written personal profiles describing the company commander, platoon sergeant, and the three squad leaders. The experimenter told the subject that the role players would play the personalities of the individuals depicted in the profiles. These profiles provided cues that would affect the decisions made by the subject (platoon leader) during the scenarios, e.g., which squads to deploy.

After reading the profiles, the subject, the company commander, and the O/C met in the LWTB conference room. The company commander briefed the mission to the subject who was given a chance to ask questions and then allowed 10-15 minutes to develop his plan. The subject then briefed his plan to the squad leaders and the platoon sergeant. The O/C completed the *Adequacy Scale* at this time.

The subject and squad leaders then proceeded to the simulator bay and to their assigned immersible SVS systems. The company commander moved to the desktop system co-located with the immersible SVSs. The platoon sergeant stayed, for the most part, with the company commander. After completing system checks on the SVSs and the communication nets, the scenario started.

For each scenario, the ARI researcher recorded decision point responses on the PC while the O/C provided limited coaching as needed. After the completion of the first scenario (pre-test), the O/C provided immediate feedback to the subject on key actions that he missed (e.g., failure to have squad immediately mask when informed of chemical agent leak, failure to call for cease fire after fratricide incident) or incorrect information

provided to the squad leaders or to the company commander. The O/C then completed the *Initiative* and *Intent Scales* along with the SABARS. The subject filled out the PSAQ at this time. Concurrently, the squad leaders completed the *Execution Scale*, and the company commander completed the *Leader's Rationale* and *Mission Performance Scales*. The trial concluded with an After Action Review (AAR) that was led by the company commander. At this time the subject summarized the mission and was asked by the company commander to elaborate on key events and discuss specific lessons learned. Additional feedback was provided by the role players and the O/C.

Trials two and three were identical to trial one (pre-test) with one exception. At selected points during these scenarios, a SAGAT stop was announced and the scenario halted at that point. At this time the SAGAT technician wheeled a cart into the SVS. The cart held the lap top system and allowed the subject to remain in place. The platoon leader was given four minutes to complete the SAGAT items (results from the earlier rehearsals indicated this time interval was sufficient to complete all items). During this same time, the company commander completed a paper-and-pencil version of the SAGAT. There were three SAGAT halts for each scenario (Company Assault and Defend). With the exception of rotating scenarios, trial four (post-test) was run identically to trial one (pre-test). For the experienced group, the first trial was always Secure Village and trial four was SASO. For the inexperienced group, the order was reversed (i.e., SASO for trial one and Secure Village for trial four). Trials two (Assault) and three (Defend) were presented in the same order for both groups.

Results

Analyses were guided by three major questions: 1) Did decision-making/SA improve over trials?; 2) Did level of experience moderate the rate of learning over trials?; 3) What was the relationship between decision-making and SA?

Observer/Controller (O/C) Decision-Making/Leadership Ratings

Separate mixed-factor repeated measures analyses of variance (ANOVA) were computed for each of the decision-making/leader rating scales completed by the O/C. This included the Adequacy (of the plan), Initiative, and Intent Scales. ANOVAs were performed for only the global rating items of each scale. The alpha required for significance in all analyses was set at $p < .05$.

No significant group (experience), trial, or group-by-trial interaction effects were obtained. Overall, the experienced group received higher scores than the inexperienced group on all scales, but the differences were slight. The majority of ratings for the experienced group were in the "good" range (4.00 - 4.29). Overall, the ratings for the inexperienced group fell about one-half point below the experienced group (3.57 - 3.86).

Company Commander Decision-Making/Leadership Ratings

Separate analyses for the Leader's Rationale and Mission Performance Scales (global ratings) revealed no significant differences. Both the experienced and inexperienced groups tended to be rated equally high (3.7 - 4.1) on each scale.

Squad Leaders' Decision-Making Leadership Ratings

Analyses of the squad leaders' global ratings from the Execution Scale showed a tendency for improved clarity of communication over trials, but the differences were not significant. Ratings indicated that platoon leaders became clearer in their instructions, (i.e., simple and sufficient instructions, clear intent) to the squad leaders over time. Overall, the ratings clustered around the "borderline" to "good" range.

Objective Assessment of Decision-Making Skills

Each time a subject failed to take a specific, tactically advisable action listed under a given decision-point, this non-action was noted, the entry time stamped and saved. These non-actions (errors) were then summed and a percentage was calculated based on the total number of possible non-actions for each decision point. The resulting metric (percentage of incorrect responses) provided a measure of decision-making competency over trials.

The results from the repeated measures ANOVA revealed a significant trial effect, $F(3, 36) = 3.3$, $p < .04$. Figure 1 depicts a non-linear pattern over trials. Decision-making errors (failure to act) increased from trials 1 and 2, and then decreased over the remaining trials.

Overall, there was a tendency for the experienced group to make fewer errors over trials than the inexperienced group. A post-hoc comparison (Keppel, 1973, p. 411) was calculated between trials one and four. The resulting comparison approached statistical significance ($.05 < p < .06$). Fewer errors were made in trial four than in trial one.

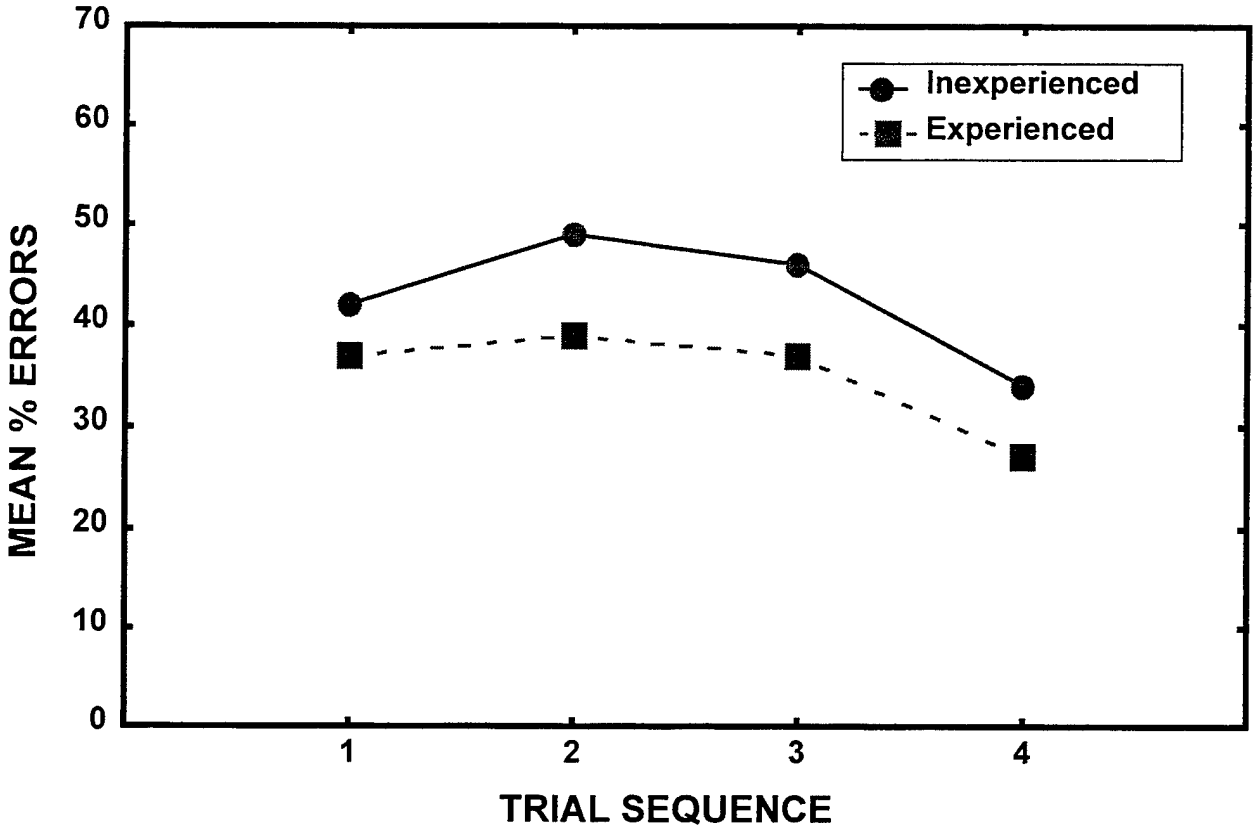

Figure 1. Mean percentage of decision-making errors over trials by group.

Each decision point included an extra category to cover unexpected or unforecasted actions made by each subject. These responses were analyzed separately from the other responses. Interestingly, the experienced group engaged in more unforecasted actions (47) than the inexperienced group (25). Group differences were most pronounced for the Secure Village and Defend scenarios.

Subjective Ratings of Situation Awareness

Mixed factor repeated measures ANOVAs were computed for the two subjective measures of SA, the Situation Awareness Behaviorally Anchored Rating Scale (SABARS), and the Post-Trial Participant Subjective SA Questionnaire (PSAQ). For the SABARS, individual responses (except the global response item) were combined and a mean SA score was computed for each subject. The results from the SABARS analyses revealed a trend for SA to improve over trials, based on the O/C's subjective assessment. The experienced group also tended to receive higher ratings (2.73 - 3.0) than the inexperienced group (2.62 - 2.76) over trials. Neither the group, trial, or group-by-trial interaction effects reached established significance levels, $p > .05$.

With regard to the PSAQ ratings, each item was analyzed separately. Subjects' perceived levels of situation awareness did not significantly improve over trials. For the

most part, both groups' self-ratings were on the high side (3.71 - 4.14) indicating a fairly high level of situation awareness across trials.

No significant differences were found on how well subjects thought they performed during the trials or for work effort. There was a tendency, however, for both groups to work hardest during the assault scenario.

Objective Ratings of Situation Awareness

Items from the Situation Awareness Global Assessment Technique (SAGAT) were analyzed (ANOVA) separately since previous research has shown that SA accuracy on individual items is dependent on different aspects of the situation. For this reason, a single combined SAGAT score was not used in the analyses (Slater, Endsley, Pleban, & Matthews, 2001).

The most noteworthy findings centered around experience levels and items asking the subjects to identify various elements on a map. The results from the analyses showed that experienced officers were significantly better at locating both enemy troops [$F(1, 69) = 4.81$, $p < .04$] and elements of their own platoon [$F(1, 69) = 5.19$, $p < .03$] on the map. The results also showed that experienced officers were better at identifying both the strongest enemy locations [$F(1, 59) = 8.14$, $p < .01$] and the location of the element posing the highest threat to their platoon [$F(1,59) = 6.48$, $p < .02$] than inexperienced officers. Conversely, inexperienced officers were better at identifying the locations of the strongest friendly elements than experienced officers, $F(1,59) = 6.89$, $p < .02$.

Comparison of Situation Awareness Measures

The three SA measures were compared through a series of step-wise regression analyses to determine whether the behaviors rated on the SABARS and the self-ratings (PSAQ) were predictive of the level of objective SA as measured by the SAGAT procedure. Separate analyses were performed with each of the SAGAT items serving as criterion variables. (Each SAGAT item used in the analyses represented a mean score based on the subject's responses to the item over the six halts.)

To enhance the interpretive value of the SABARS, item scores were subjected to a factor analysis (see Strater, Endsley, Pleban, and Matthews, 2001). The resulting analysis combined the 20 items completed by the O/C for each scenario into four factors. These factors were labeled by Strater et al. (2001) as: *Gathering Information and Following Procedures* (e.g., Uses assets to effectively assess environment); *Focusing Inside the Platoon versus Outside the Platoon* (e.g., Communicates key information to commanding officer); *Proactively Seeking Key Information*, (e.g., Employs squads tactically to gather needed information); and *Focusing on the Big Picture* (e.g., Communicates key information to squad leaders).

Results showed that two SABARS factors (*Proactively Seeking Key Information* and *Focusing on the Big Picture*) and two PSAQ measures (self-rated SA and workload) accounted for a significant ($p < .05$) part of the variance (15.1 - 41.3 percent) in five SAGAT items. The five SAGAT items that were best predicted from the SABARS and PSAQ measures included: a) percentage of enemy locations correctly identified; b) number of adjacent friendly units correctly identified; c) correct identification of strongest enemy opposing force locations; d) correct identification of the number of casualties suffered and; e) degree of awareness of which force had the advantage. A complete description and discussion of the three SA measures, their interrelationships, and additional experimental findings are provided by Strater et al. (2001). Overall, the results showed that the SABARS and PSAQ were not strong predictors of objective levels of SA.

Predicting Decision-Making Accuracy from Situation Awareness Measures

A step-wise regression analysis was computed using the decision-making accuracy scores of the subjects and their responses from the three situation awareness measures collected during the assault and defend scenarios. Scores from 13 SAGAT items, the four SABARS factors, and the three (PSAQ) items served as the predictor variables. The platoon leader decision-making accuracy score served as the criterion. Five of the SA measures, as shown in Table 3, predicted 69% of the variance in decision-making accuracy. One key predictor was the SABARS factor *Focused Inside the Platoon versus Outside the Platoon.* This factor included O/C ratings for the items "Communicates key information to commanding officer"; "Gathers follow up information when needed"; "Asks for pertinent intelligence information"; "Assesses key finds and unusual events" and; "Discerns key information from reports received". The participants' self-rated workload, and their SAGAT scores indicating the degree to which they were aware of exposed friendlies, which side had the advantage, and which elements were not in communication with them all contributed to explaining the variance in the decision score.

Table 3

Summary of Stepwise Regression Analysis for Variables Predicting Decision-Making Accuracy (N = 27)

Variable	B	SE B
Step1		
• **SABARS**-Information Gathering	-.045	.012
Step 2		
• **SABARS**-Information Gathering	-.031	.014
• **SABARS**-Focus In vs. Out	-.032	.017
Step 3		
• **SABARS**-Information Gathering	-.027	.014
• **SABARS**-Focus In vs. Out	-.033	.016
• **SAGAT**-Awareness of Not In Communication	.094	.060
Step 4		
• **SABARS**-Information Gathering	-.018	.013
• **SABARS**-Focus In vs. Out	-.050	.016
• **PSAQ**-Self-Rated Workload	.054	.022
• **SAGAT**-Awareness of Not In Communication	.153	.060
Step 5		
• **SABARS**-Focus In vs. Out	-.063	.013
• **PSAQ**-Self-Rated Workload	.064	.022
• **SAGAT**-Awareness of Not In Communication	.175	.059
Step 6		
• **SABARS**-Focus In vs. Out	-.071	.013
• **PSAQ**-Self-Rated Workload	.076	.021
• **SAGAT**-Awareness of Exposed Friendlies	.113	.057
• **SAGAT**-Awareness of Not In Communication	.198	.057
Step 7		
• **SABARS**-Focus In vs. Out	-.071	.013
• **PSAQ**-Self-Rated Workload	.063	.023
• **SAGAT**-Awareness of Exposed Friendlies	.103	.056
• **SAGAT**-Awareness of Advantage	-.103	.071
• **SAGAT**-Awareness of Not In Communication	.212	.056

Note. $R^2 = .37$ for Step 1, $\Delta R^2 = .11$ for Step 2, $\Delta R^2 = .05$ for Step 3, $\Delta R^2 = .10$ for Step 4, $\Delta R^2 = -.03$ for Step 5, $\Delta R^2 = .06$ for Step 6, $\Delta R^2 = .03$ for Step 7 ($p < .05$).

Subject Feedback

Subjects' responses to the Post-Experimental Questionnaire and interviews were analyzed and descriptive statistics computed. The major points are summarized below by topic area.

Training value of scenarios. Subjects rated the training value and level of challenge provided by each scenario. Table 4 shows that all scenarios provided substantial training value. Training value was enhanced by the overall difficulty and danger inherent in the scenarios, unexpected events, non-perfect performance of units and weapons, and the need to maintain good situation awareness.

Not surprisingly, the scenarios were also perceived as very challenging with the assault scenario rated the most challenging (almost too difficult) and the defend scenario viewed as the least challenging (see Table 5). Subject comments indicated that the level of challenge provided by the scenarios was due in large part to the real-time introduction of multiple events and threats that forced the individual to make quick and accurate decisions.

Separate ANOVAs were performed on the group ratings made for each scenario. The results from the analyses showed that the inexperienced and experienced groups did not differ significantly in their ratings of the training value or level of challenge provided by the scenarios.

Table 4

Training Value Provided By Scenario

Group	**Secure Village/ SASO**	**Assault**	**Defend**	**Secure Village/ SASO**
Inexperienced	M = 3.57 SD = .53	M = 3.86 SD = .38	M = 3.71 SD = .49	M = 4.00 SD = .00
Experienced	M = 3.83 SD = .41	M = 3.86 SD = .38	M = 3.67 SD = .82	M = 3.86 SD = .38

Note. 1 = No training value; 2 = Some training value; 3 = Moderate training value; 4 = Significant training value. The inexperienced group received the SASO scenario first and Secure Village scenario last. For the experienced group, the scenario sequence was the exact opposite.

Table 5

Level of Challenge Provided By Scenario

Group	**Secure Village/ SASO**	**Assault**	**Defend**	**Secure Village/ SASO**
Inexperienced	M = 3.29 SD = .76	M = 3.71 SD = .76	M = 3.00 SD = .82	M = 3.43 SD = .53
Experienced	M = 3.17 SD = 1.17	M = 3.57 SD = .53	M = 3.17 SD = .98	M = 3.43 SD = .79

Note. 1 = Not very challenging; 2 = Reasonably challenging; 3 = Very challenging; 4 = Too difficult. The inexperienced group received the SASO scenario first and Secure Village scenario last. For the experienced group, the scenario sequence was the exact opposite.

Positive training features. Subjects listed several features that enhanced the overall value of the training. The total immersion provided by the SVS enhanced the overall realism of the scenarios. All scenarios involved a fairly high operating tempo that required quick and accurate decisions that subjects found very challenging. In addition, the scenarios contained a number of unexpected events or developments that forced the subject to maintain a heightened level of vigilance throughout the mission. Finally,

subjects could see the immediate consequences of their actions or lack of action (e.g., increased number of friendly casualties from delaying order to cease-fire).

Negative training features. There were several system features that subjects felt had a negative impact on training. For some subjects, the various wires that were attached to the rifle and headset to track movement and allow for accurate target engagement constrained movement within the SVS. Moving glitches were also mentioned, as people and objects moved unexpectedly or unrealistically within or out of sight on the screen. The thumbstick located on the rifle was seen by some as very awkward. The lack of "play" in the thumbstick made it very difficult for subjects to move smoothly in the virtual environment. Response times were often too quick (e.g., soldiers moving too quickly from one destination to another). Finally, the system did not support certain key combat features, such as the tactical use of smoke during the assault mission.

Suggestions for improved training effectiveness. Some of the suggestions made by the subjects were clearly tied in to the structure and format of the scenarios. Several soldiers wanted the capability to sling their rifle in addition to having a more integrated RTO format. The nature of the scenarios required that the subject carry his map in one hand, operate the radio with another hand, and occasionally move, using the thumbstick, which required both hands. This often led to some awkwardness on the subject's part as he juggled the combination of material/equipment depending on the demands of the scenario.

Some subjects also indicated that they wanted to be able to move with the maneuver element. While limited movement within a defined area was acceptable, extensive movement was discouraged because, based on past observations, subjects who were allowed to move extensively tended to either get lost or "stuck" in walls. This could affect their ability to focus on the extensive message traffic directed their way and result in missed training cues. This, in fact, was observed twice, and the subjects suffered the consequences (e.g., killed, lost or stuck). Under less rigidly developed scenarios, allowing the subjects to move with their maneuver elements would have some merit.

Overall, this virtual environment training was seen as particularly effective for the inexperienced lieutenant, with the proviso that he have a basic knowledge of fundamental infantry operations. Virtual decision skills training was viewed by some subjects as the "walk" phase of the training process that needs to be combined with the appropriate field experience (e.g., actual training time at the McKenna site) and mentoring to insure maximum benefit.

Using virtual environment technologies for improving decision-making skills. Subjects were almost unanimous in their views on using virtual environment technologies to train decision-making skills. Eighty-six percent (12/14) of the subjects felt their decision-making skills had improved as a result of the training they received. All subjects indicated that decision-making skills could be effectively taught using virtual environment technologies. Finally, ninety-three percent of the subjects indicated they

would like to see some form of virtual environment decision-skills training included in the Infantry Officer Basic Course (IOBC) curriculum.

Discussion

While our findings are preliminary, the pattern of results obtained suggests that: 1) real-world decision-making skills can be trained in virtual environments; 2) a virtual environment can be used as a test bed for developing decision-making/SA measures and; 3) SA appears to play a role in moderating decision-making accuracy in simulated dismounted infantry environments.

Training Real World Decision-Making Skills in Virtual Environments

Assessing decision-making skills. Based on objective decision-point data, performance did improve (fewer decision errors) from trial one to trial four. The curvilinear pattern of improvement depicted in Figure 1 was unexpected, however. This relationship could be scenario dependent. Both groups executed the assault scenario during trial two. This scenario was rated as the most challenging of the four scenarios. In fact, the high ratings (3.57 - 3.71, on a four-point scale) suggest that for some subjects, the scenario bordered on the too difficult side.

The presentation of scenarios was not completely counterbalanced. As noted earlier, the inexperienced group received the SASO scenario as the pre-test and the Secure Village as the post-test. This order was the exact opposite for the experienced group. Within each group roughly one-half of the subjects should have received the SASO as the pre-test and Secure Village as the post-test. The remaining subjects should have received the same scenarios in reverse order.

Subsequent analyses indicated that the confound of scenario order (specifically trials one and four) within groups did not preclude preliminary assessments concerning the impact of the training on decision-making. The experienced and inexperienced groups did not differ (significantly) in their ratings of either the training value or level of challenge provided by the scenarios. This is reflected in Figure 1 which shows that the pattern of responses over trials was essentially identical for both groups. The confounding of scenario order within groups, in this instance at least, cannot adequately explain the improvement in decision-making between trials one and four.

With the possible exception of the Execution Scale, none of the subjective paper-and-pencil measures of leadership/decision-making yielded anything of substance. There may be several reasons for the relative insensitivity of the measures. First, all the paper-and-pencil measures (e.g., the Adequacy, Initiative, Intent, Leader's Rationale, Mission Performance, as well as the Execution Scales) were composed predominantly of yes-no questions. Only the global rating item at the end of each scale included a multi category, five-point Likert rating format. Some raters felt that they could have made finer discriminations if all items employed this same format.

Second, the scenarios may have also contributed to rating insensitivity for certain scales. The well-scripted scenarios left little room for major discrepancies among plans that could be observed across subjects based on the Adequacy (of the plan) Scale ratings provided by the O/C. It should also be noted that planning was one activity/process that all subjects, experienced and inexperienced alike, had been exposed to, in varying degrees as part of their prior training. It may not be surprising then, that all subjects had a good "feel" for the planning process at the platoon level. This may have further contributed to their high ratings (in the "good" range) across scenarios.

Finally, instruction in the use of the instruments and what to look for was not stressed enough during training for the role players and the O/C. The biggest concern during training was insuring that all role players had learned their cues concerning when to respond, what to say, and how to synchronize their responses with others. This proved to be more complex than initially anticipated. Not surprisingly, the training related to how to use the rating instruments was minimized. More emphasis was needed in explaining the purpose of each instrument, pilot testing the scales, and fine-tuning the instruments prior to the experiment.

Implementing a virtual environment training system. Subject responses were clearly positive regarding the use of virtual environment technologies for training decision-making skills. The majority of subjects felt that implementation of virtual environment decision-skills training would be most appropriate at the IOBC level. Implementation at this level does, however, present some problems. One problem that must be addressed is class size. With classes of up to 250 and more, no clear solution could be devised, during post-experiment interviews, for how to rotate all students through a limited number of SVS systems and still insure some training value. All subjects agreed that exposure to multiple scenarios was critical for learning. Most subjects felt they would have to execute at least two scenarios to derive any training benefit.

Another problem is the necessity of having some type of automated assessment system to track subject actions over key decision points during the course of the scenario, to summarize the responses, and to display these summary data quickly after the completion of a trial in order to supplement the AAR process.

The current experiment did allow subject actions to be tracked over time, but summary data were not available until after the experiment and all graphic displays had to be manually created by the experimenter. Furthermore, a live person was needed to record the actions of the subject; this could not be accomplished automatically. In the training environment, a system is needed to free an instructor from having to manually enter data at each decision-point and would, for the most part, automate the graphic and tabular summaries of the data. This would greatly alleviate the training burden on the instructor(s).

Overall, the immersive environment created by the SVS systems provided the opportunity to simulate conditions similar to what the soldier might experience in the real

world (i.e., fluid, dynamic environments that required quick, rapid decisions). Soldiers were clearly challenged and they could both see and hear the consequences of their actions unfold in real time on the screen and in subsequent message traffic received from the squad leaders, platoon sergeant, and the company commander. Maybe more importantly, this could all be accomplished in a safe training environment where subjects can be easily regenerated if killed, and can actually profit by learning from poor decisions made in earlier scenarios.

Using the Virtual Environment as a Test Bed for SA Instrument Development

As noted earlier, one reason why SA has not been as thoroughly researched in dismounted infantry settings as opposed to other settings (e.g., aviation) may be the difficulty involved in employing the SAGAT in real life training environments. The majority of aviation settings employing the SAGAT process involve simulation environments. Under these conditions the researcher has more control of events and the halts are not as disruptive as if, for example, an entire platoon field training exercise were interrupted.

In field exercises, if multiple halts are intertwined throughout the exercise, precise control of action (stops and starts) can be difficult, particularly in areas where the platoon leader is not present. The stopping and starting can also seriously degrade the momentum of the training. Adding to the disruption is the fact that data would most likely be collected from just the platoon leader, while the rest of the platoon waited twenty to twenty-five minutes (total time) for the leader to complete his SAGAT questioning. This would clearly be an inefficient use of field training time for the rest of the platoon.

Conducting the SAGAT in a virtual training environment was far more efficient. Disruptions were relatively minor. Only the subject was inconvenienced (if at all) by the breaks in the action. The SAGAT halts were not a major distraction for the role players, data collector, or technical support personnel. The relatively controlled setting of the LWTB also provided an ideal work environment for the development of less invasive subjective paper-and-pencil SA measures that could be more effectively employed in field environments.

One of the key research objectives in this area was to compare the scores on the two subjective measures with scores obtained from items using the SAGAT process. The SAGAT procedure has been used extensively by Endsley (e.g., Strater, Endsley, Pleban, & Matthews, 2001) and provides valid, objective measures of individual SA. Based on the analyses that were performed, the prediction of specific SAGAT responses from SABARS factor scores and the three PSAQ items was poor. This may reflect low predictiveness of some of the SABARS factors, or that SABARS and SAGAT are tapping into unrelated aspects of SA. It may also reflect the relatively small sample in the experiment.

Inspection of the item content from both the SABARS and SAGAT supports the notion that both instruments are addressing different aspects of SA. SABARS items focus primarily on how well the subject acquires and disseminates information from different sources. SAGAT items focus more on the outcome of this information processing, i.e., locating friendly and enemy locations on a map, projecting likely actions of friendlies/enemies based on the information and location. While, logically, there should be some connection between the two sets of measures, it is possible that the rigid structure of the scenarios minimized the variability of ratings, particularly the O/C's SABARS ratings. This, in turn, may have attenuated the SABARS-SAGAT relationship.

PSAQ items focused on the subject's self-ratings of SA, workload, and quality of work. Workload and SA did relate significantly to certain SAGAT items. It is important to note that subjects received immediate feedback on their actions from the O/C prior to completing the PSAQ. It is possible that the O/C's comments may have affected their subsequent SA ratings (e.g., making the subjects aware of key situational cues that they may have missed). This could explain, to some degree, why both groups' self-ratings of SA were fairly high across trials. In summary, while the relationships observed among the three SA measures were modest (but significant) additional research is needed to develop a clearer linkage between these measures and decision-making.

Strater et al. (2001) provide a thorough discussion of the SAGAT, SABARS and PSAQ and implications for future research For the present report, the main objective was to show that a virtual environment could, in fact, serve as a test bed for the development and validation of SA measurement instruments. In this case, the research performed at the LWTB provided significant insights on the potential utility of the different measures of SA and highlighted key issues for further investigation (e.g., training new officers how to effectively assess and utilize information related to enemy disposition).

The Decision-Making/SA Linkage

Items (factors) from all three SA measures contributed significantly to the prediction of decision-making accuracy. Five items formed one of the SABARS factors that Strater et al. (2001) labeled Focusing *Inside the Platoon vs Outside the Platoon.* These items appear tied to how well the subject acquires (e.g., Gathers follow-up information when needed) and disseminates (e.g., Communicates key information to commanding officer) information within his platoon. It makes sense that if a subject knows what information to ask for, can discern the critical information from reports, finds, and unusual events (items addressed by this factor), his SA should be higher. This should lead to, among other things, improved decision-making capability.

The cluster of items composing the SABARS factor *Focusing Inside the Platoon vs Outside the Platoon* may also provide some valuable insight to trainers on how to effectively tailor a training program to improve decision-making/SA capabilities. Many of these items are concerned with an individual's ability to assess the importance of various pieces of information from much larger pools of information, discern critical

cues, etc. The ability to read cues, and understand the significance of these cues is key for making rapid, accurate decisions in real world environments and forms the cornerstone of the work presented by Klein (1997) and Endsley (1997).

As different aspects of SA undoubtedly contribute to different decisions at different times, it is likely that different SA measures would be related more to individual decisions rather than to a combined decision score such as that investigated here. This issue should be explored further.

Overall, these results are consistent with previous work in related areas; nevertheless, the findings should be viewed as preliminary. Many of the SA scores were inter-correlated, which can affect the degree to which factors will appear as significant within a step-wise regression (see Strater, Endsley, Pleban, and Matthews, 2001). Moreover, the results from both the regressions and the factor analysis conducted on the SABARS should be interpreted cautiously given the sample size of the present study. To more thoroughly investigate the relationship between aspects of SA and decision-making effectiveness would require a larger study with more subjects and a wider range of scenarios (counterbalancing the order of scenario administration across subjects) and decision types. Ultimately, there should be some demonstration that virtual decision/SA skills training effects transfer to similar real world scenarios.

With these caveats in mind, these results indicate that there was some degree of predictiveness associated with this subset of the SA measures taken and the decision scores analyzed here. This finding would indicate that further work in examining SA and its effect on military decision-making is warranted.

Conclusion

This research showed that real world decision-making skills could be trained using virtual technologies. While the design/format was too resource intensive (number of SVSs used, large support base-system maintenance personnel, confederates, poor automated data collection, tracking and analysis capability) for efficiently training one soldier, a number of partial solutions are possible. For example, instead of training only one soldier at a time, a group of soldiers (five) could be trained. This would require changing the structure of the scenarios, e.g., (less rigid scripting, and inserting additional subjects into role player positions). Efforts are also underway to automate the data collection/ tracking/analysis capability of the system to make it more user friendly for trainers.

From an organizational/institutional standpoint, implementation of virtual training technologies into a formal course curriculum (i.e., IOBC) may not be feasible at this time. A number of questions must be answered. For example, would any subject areas have to be modified or removed from the curriculum? If yes, which ones? How would this process be determined? How could this training be introduced to insure maximum training value for the soldier? As mentioned earlier, soldiers would require multiple exposures to different scenarios to receive any training benefit. Would IOBC course

developers be willing to make the necessary cuts/modifications in their current course curriculum to insure adequate training time in the simulators? Thus, while virtual environment technologies, in concept, can be a potent tool for training decision-making skills, there are still many pragmatic concerns that must addressed before this type of training is incorporated in formal school (e.g., IOBC) instruction.

From a feasibility standpoint, these virtual environment technologies may be more suitably employed at the unit level for select elements (e.g., special operations forces). These systems can be effectively used during mission rehearsal activities (Pleban, Eakin, & Salter, 2000) or as an aid to enhance the AAR process (see Clancy, 1998).

The present research has shown that a virtual environment can be used as a test bed for the development of SA measurement instruments. It can also serve as an effective medium for conducting both basic and applied research in decision-making and SA. Valuable insights were obtained on how to refine training procedures for improving real world decision-making skills. In addition, conducting research in the controlled setting of the LWTB permitted closer empirical scrutiny of the linkage between decision-making and situation awareness in dismounted infantry operations and suggested new directions for further work in these areas.

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Appendix A

Biographical Information Questionnaire

Name_____ Unit_____ Date_____

Please fill in the blank or mark or circle the appropriate response.

1. What is your age? _____ Years

2. MOS _____

3. Rank _____

4. Time in service Years _____ Months _____

5. What is the source of your commission?

   _____ROTC _____USMA _____OCS

6. What is your current (or most recent) duty position? _____
How long in this position? _____

7. What Army training courses have you completed? Check all that apply.

   _____ OSUT/AIT _____ PLDC _____BNCOC _____IOBC

   _____BFV Leader Course _____ Airborne _____ Ranger

   _____Air Assault _____Combat Life Saver Course

   _____Other (please specify)_____

8. How susceptible to motion or car sickness do you feel you are?

1	2	3	4	5	6	7
not susceptible			moderately susceptible			highly susceptible

9. Do you have normal or corrected to normal 20/20 vision? _____Yes ____No

10. Are you color blind? _____Yes _____No

11. Are you _____right handed? _____left handed?

12. My level of confidence in using computers is

1 2 3 4 5
low average high

13. How many hours per week do you use computers? _____ hours per week

14. How many times in the last year have you experienced a virtual reality game or entertainment?

0 1 2 3 4 5 6 7 8 9 10 11 12+

15. How often have you trained at the McKenna MOUT site (not including demos)?

_____ not since basic training _____1-3 times _____more than 3 times

16. Have you ever been in a Virtual Individual Combatant (VIC) simulator at the Land Warrior Test Bed before?

_____Yes _____No

If YES, which one(s)? (Describe if you cannot remember the name)

17. Have you had any <u>other</u> experience with military computer simulations?

_____Yes _____No

If yes, please describe briefly or give the names of the simulators.

Appendix B

Subject Name_____ **Date**_____

Adequacy of the Plan		
Rate the adequacy of the plan based on the following characteristics.	**Yes**	**No**
• **Mission statement clearly identified, i.e., who, what, when, where, and why.**		
• **Mission statement included an end state, i.e., how things should look when the mission is complete.**		
• **Provided the appropriate level of detail for the situation.**		
• **Recognized and utilized available terrain and resources.**		
• **Provided a feasible approach for the situation.**		
• **Assumed a thinking enemy.**		
• **Analyzed the enemy.**		
• **The plan was decisive.**		
• **The plan was easy to understand.**		
• **The platoon leader's plan reflected a clear understanding of all relevant mission factors.**		
• **Overall, how would you rate the plan?** **_____Very Good _____Good _____Borderline _____Poor _____Very Poor**		

Comments:

Appendix C

Subject Name_____ **Date**_____

Appropriate Level of Initiative		
Rate the level of initiative demonstrated by the platoon leader based on the following actions.	**Yes**	**No**
• **Decisions were made in a timely fashion.**		
• **The platoon leader was able to recognize and define emerging problems.**		
• **The platoon leader involved the squad leaders in decisions where appropriate.**		
• **Platoon leader actions were appropriate for the situation.**		
• **The platoon leader remained decisive throughout the mission.**		
• **The platoon leader took control of the situation without delaying and waiting for orders.**		
• **The platoon leader was able to improvise within the commander's intent.**		
• **The platoon leader was able to work effectively in a fluid environment.**		
• **Overall, how would you rate the level of initiative demonstrated by the platoon leader?** **_____Very Good _____Good _____Borderline _____Poor _____Very Poor**		

Comments:

Appendix D

Subject Name_____ **Date**_____

Plan's Fit within Commander's Intent		
Rate the platoon leader's ability to tailor his plan within the larger plan presented.	**Yes**	**No**
• **The platoon leader understood that his platoon is part of a larger unit and acted accordingly.**		
• **Actions were taken based on the intent of higher command.**		
• **The plan considered other friendly units.**		
• **How well did the platoon leader's plan fit within the scope of the commander's intent?** **_____Very Good _____Good _____Borderline _____Poor _____Very Poor**		

Comments:

Appendix E

Subject Name_____ **Date**_____

Leader's Rationale	Yes	No
• Decisions were based on a reasonable assessment of the enemy.		
• The platoon leader understood the strengths/weaknesses of his situation.		
• The platoon leader's actions reflected his understanding of the opportunities and dangers of the situation.		
• The reasons behind the platoon leader's actions were sound.		
• How would you rate the platoon leader's overall understanding of the situation? _____Very Good _____Good _____Borderline _____Poor _____Very Poor		

Comments:

Appendix F

Subject Name_____ **Date**_____

Mission Performance	Yes	No
• Was the mission accomplished?		
• Were excessive casualties taken in the execution of the mission?		
• Were excessive civilian casualties taken in the execution of the mission?		
• Was the mission accomplished in a timely fashion?		
• Overall, how would you rate the performance of the mission? _____Very Good _____Good _____Borderline _____Poor _____Very Poor		

Comments:

Appendix G

Subject Name_____ **Date**_____

Execution	Yes	No
• Were orders clear?		
• Were the instructions simple and sufficient given the circumstances?		
• Did you understand what the platoon leader was trying to accomplish?		
• Overall, how would you rate the execution of the plan? _____Very Good _____Good _____Borderline _____Poor _____Very Poor		

Comments:

Appendix H

Situation Awareness Behaviorally Anchored Rating Scale (SA BARS)

Participant _____ **Scenario** _____ **Date**_____

Rating Items	Very Poor	Poor	Borderline	Good	Very Good	Not Applicable
1. Sets appropriate levels of alert	1	2	3	4	5	0
2. Solicits information from squad leaders	1	2	3	4	5	0
3. Solicits information from civilians	1	2	3	4	5	0
4. Solicits information from commanders	1	2	3	4	5	0
5. Effects coordination with other platoon leaders	1	2	3	4	5	0
6. Communicates key information to commander	1	2	3	4	5	0
7. Communicates key information to squad leaders	1	2	3	4	5	0
8. Communicates key information to other platoon leaders	1	2	3	4	5	0
9. Monitors company net	1	2	3	4	5	0
10. Assesses information received	1	2	3	4	5	0
11. Asks for pertinent intelligence information	1	2	3	4	5	0
12. Employs squads tactically to gather needed information	1	2	3	4	5	0
13. Employs graphic or other control measures for sqd. exec.	1	2	3	4	5	0
14. Communicates to squads overall situation and cdr.'s intent	1	2	3	4	5	0
15. Utilizes a standard reporting procedure	1	2	3	4	5	0
16. Identifies critical mission tasks to squad leaders	1	2	3	4	5	0
17. Ensures avenues of approach are covered	1	2	3	4	5	0
18. Locates self at vantage point to observe main effort	1	2	3	4	5	0
19. Deploys troops to maintain platoon communications	1	2	3	4	5	0
20. Uses assets to effectively assess environment	1	2	3	4	5	0
21. Performs a leader's recon to assess terrain and situation	1	2	3	4	5	0
22. Identifies OCOKA elements	1	2	3	4	5	0
23. Assesses key finds and unusual events	1	2	3	4	5	0
24. Discerns key info from maps, records & supporting site info	1	2	3	4	5	0
25. Discerns key/critical information from reports received	1	2	3	4	5	0
26. Projects future possibilities and creates contingency plans	1	2	3	4	5	0
27. Gathers follow up information when needed	1	2	3	4	5	0
28. Overall Situation Awareness Rating	1	2	3	4	5	0

Appendix I
SAGAT
(Computerized version for platoon leaders)

SAGAT INSTRUCTIONS T0 SUBJECTS

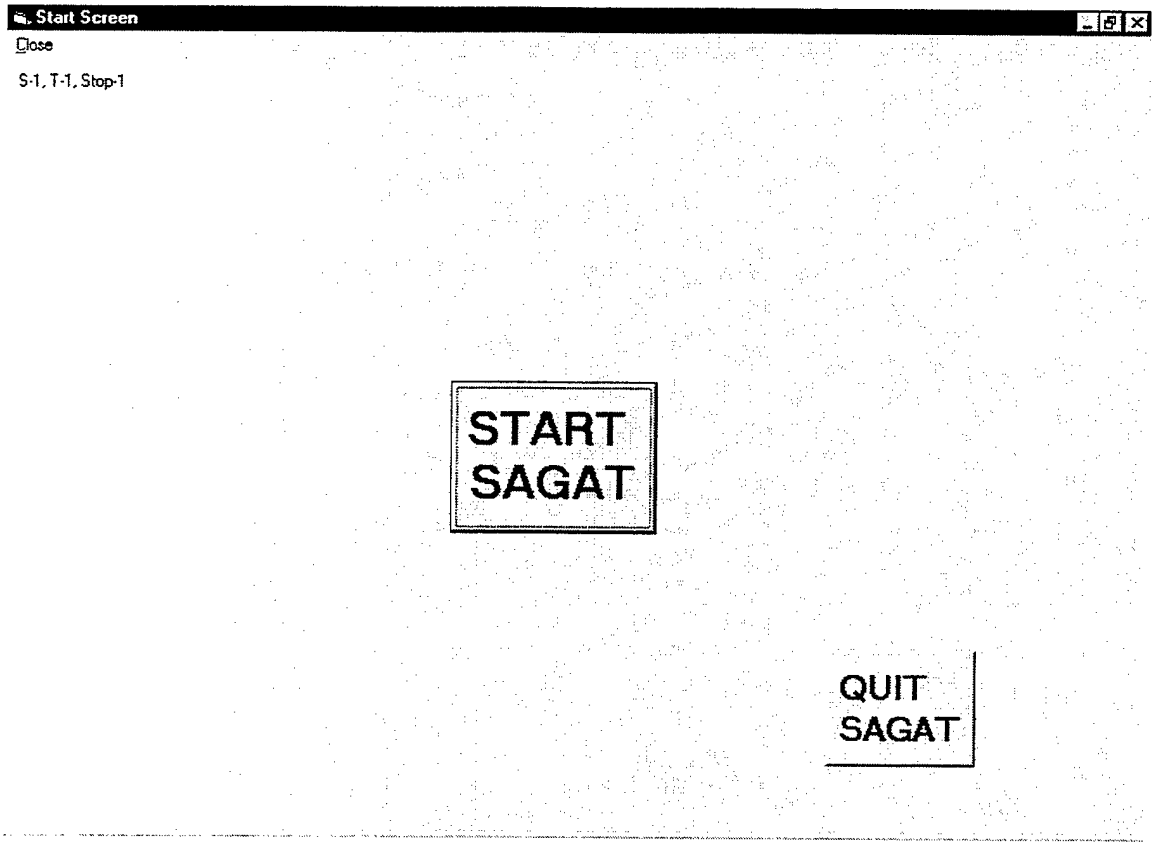
Situation awareness (SA) is critical to directing and executing Infantry operations. For the purpose of this test, situation awareness is formally defined as: *the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.* This means your perception of what is happening in the situation, including friendly, enemy, neutral, and non-combatant disposition, actions and intentions, and what that all means to you as a platoon leader.

The Situation Awareness Global Assessment Technique (SAGAT) has been developed to objectively measure situation awareness (SA) in manned simulations.

- During the trial, the simulation will be frozen at randomly determined intervals and the visual scene blanked.
- You will be asked about your knowledge of specific SA components, as you perceive them, at that point in time.
- The questions will be presented on a PC. The questions have been created to allow for quick and easy data input using the cursor.
- You will not be allowed to talk to anyone other than the Test Director when completing the questions.
- The questions should be answered as rapidly as possible.
- Even if you do not know some of the information exactly, you should make your best guess. There is no penalty for guessing. If you really have no idea at all of the answer to a question, you may simply click on the "done" box on the screen to go on to the next question. You are generally better off making your best guess, however.
- Following the SAGAT session you will resume the trial exactly where you left off. You will turn around and when ready the simulation will be resumed.

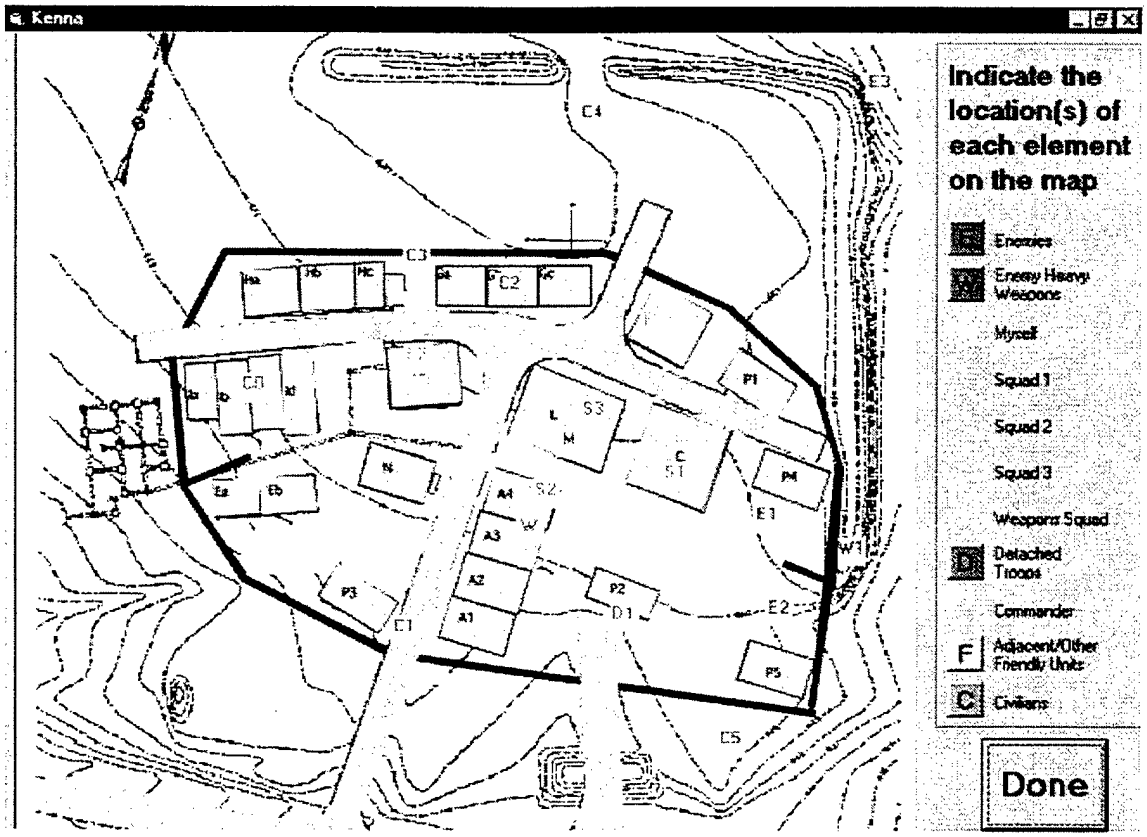
The purpose of SAGAT is to evaluate systems and training concepts, not to evaluate you as an individual. You may not be able to answer many of the questions you will be asked. Don't worry about this, as the questions are intended to assess ideal SA. Some of this information may not be available or may not be adequately accurate.

You will have the opportunity to practice answering the SAGAT questions before testing begins. Please direct any questions you may have to the Test Director.



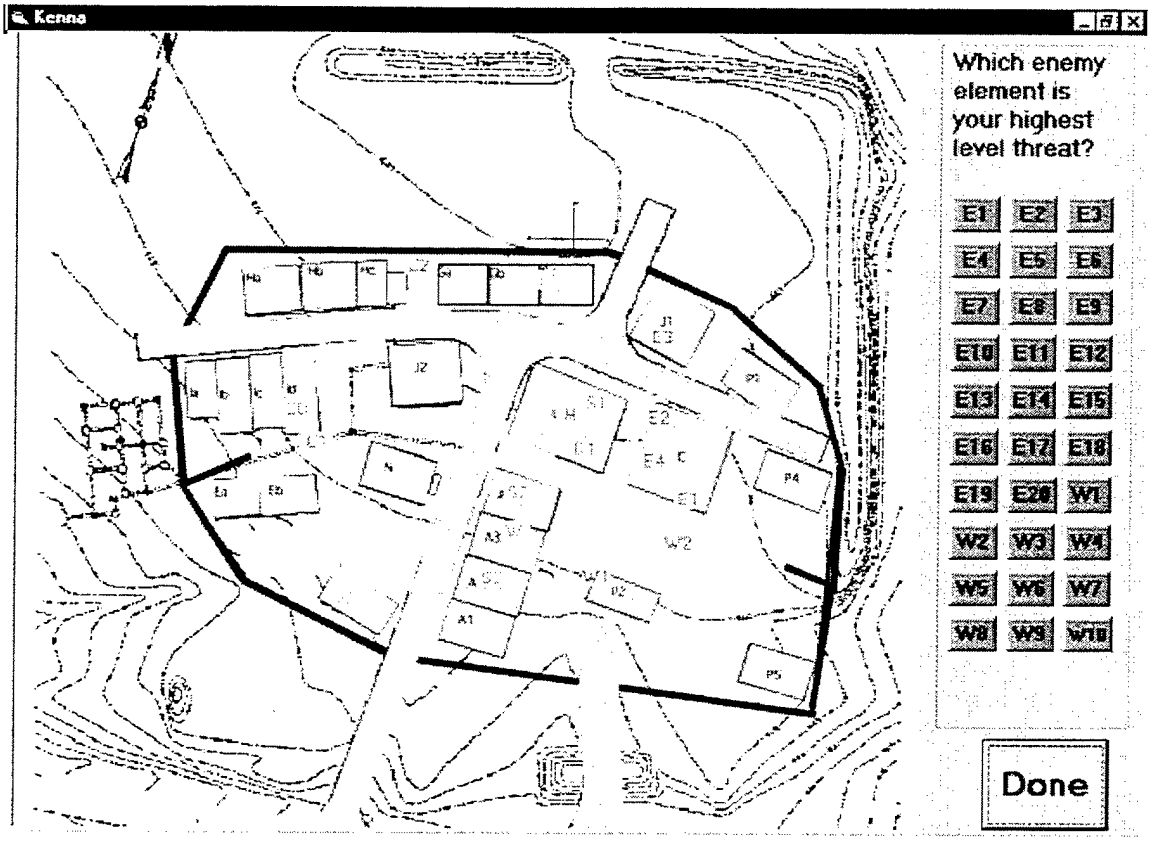
To begin the program click on the button marked "START SAGAT".

1



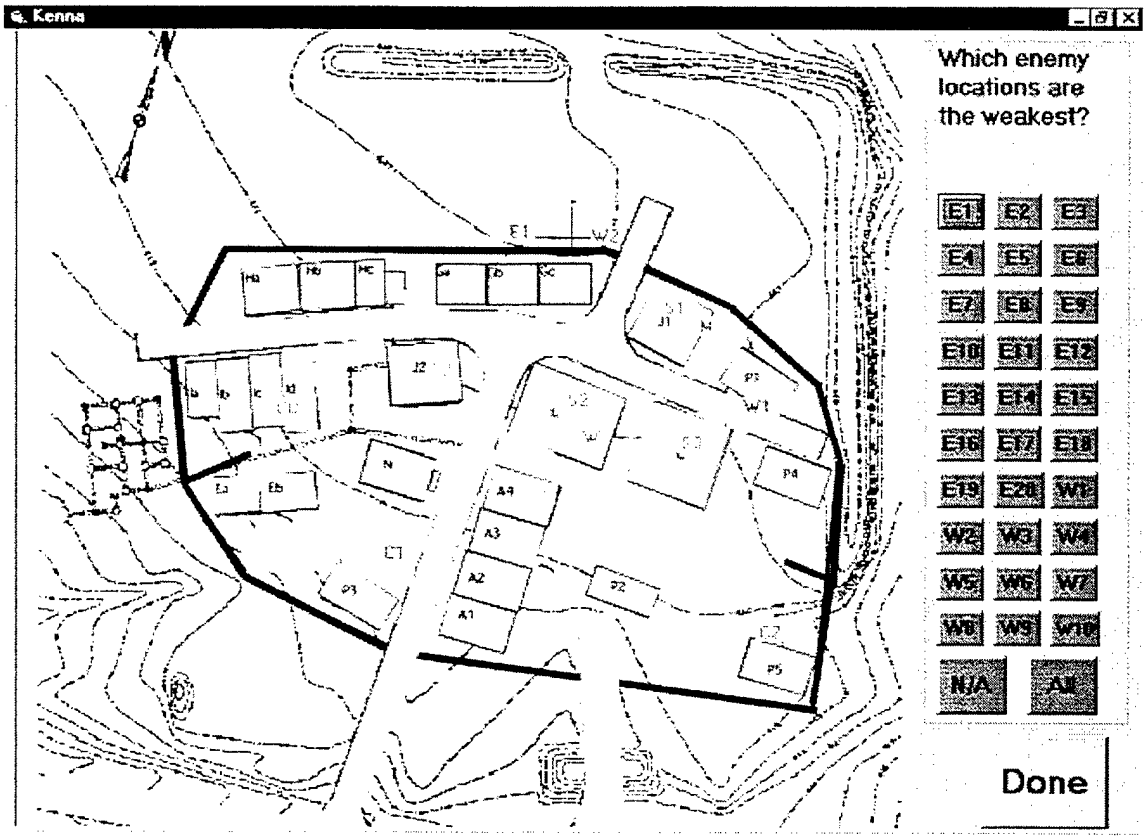
Click on the symbol next to each element that is currently alive and present in the battlefield and drag it to its current location. (You may move the symbols on the map if they are not placed correctly). Indicate the location of yourself, your commander, the main squad locations (with their squad leader), weapons squad location and any teams that have become detached from their main squads and are located separately. In addition indicate the location of any known enemies, enemy heavy weapons locations, other friendly units (outside of your platoon) and civilians. Click on the Done button when you are finished indicating the location of all known parties.

2



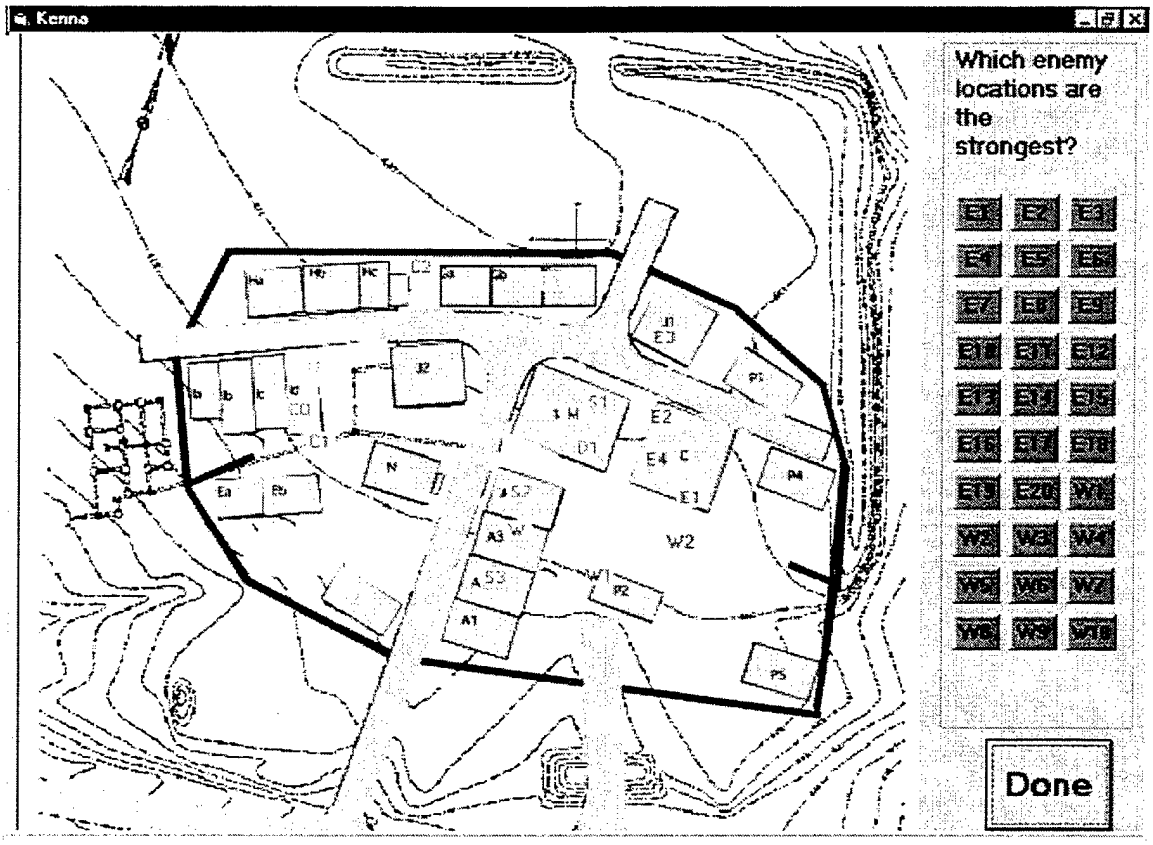
The location of all the elements you indicated in the first question are presented on the left. Click on the button that corresponds to the enemy unit that is the highest level threat to your platoon at this time. Click on the Done button when you are finished.

4



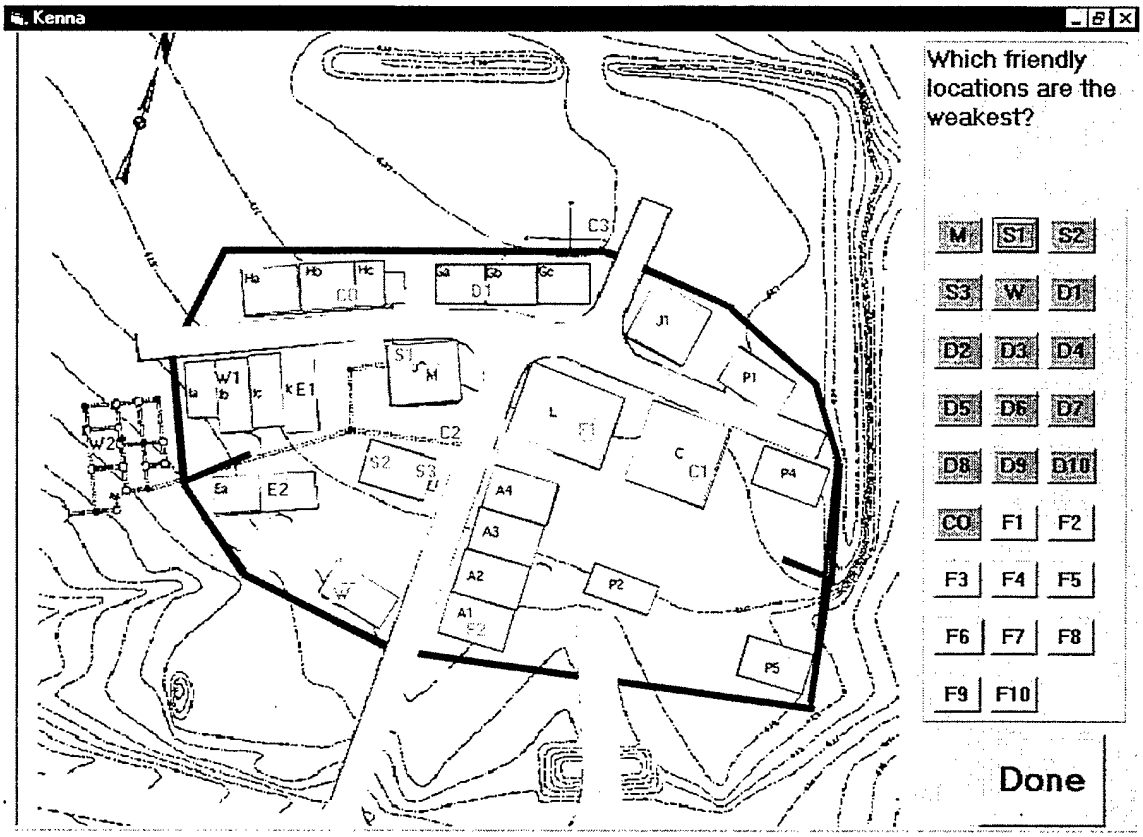
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the enemy units with the weakest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

5



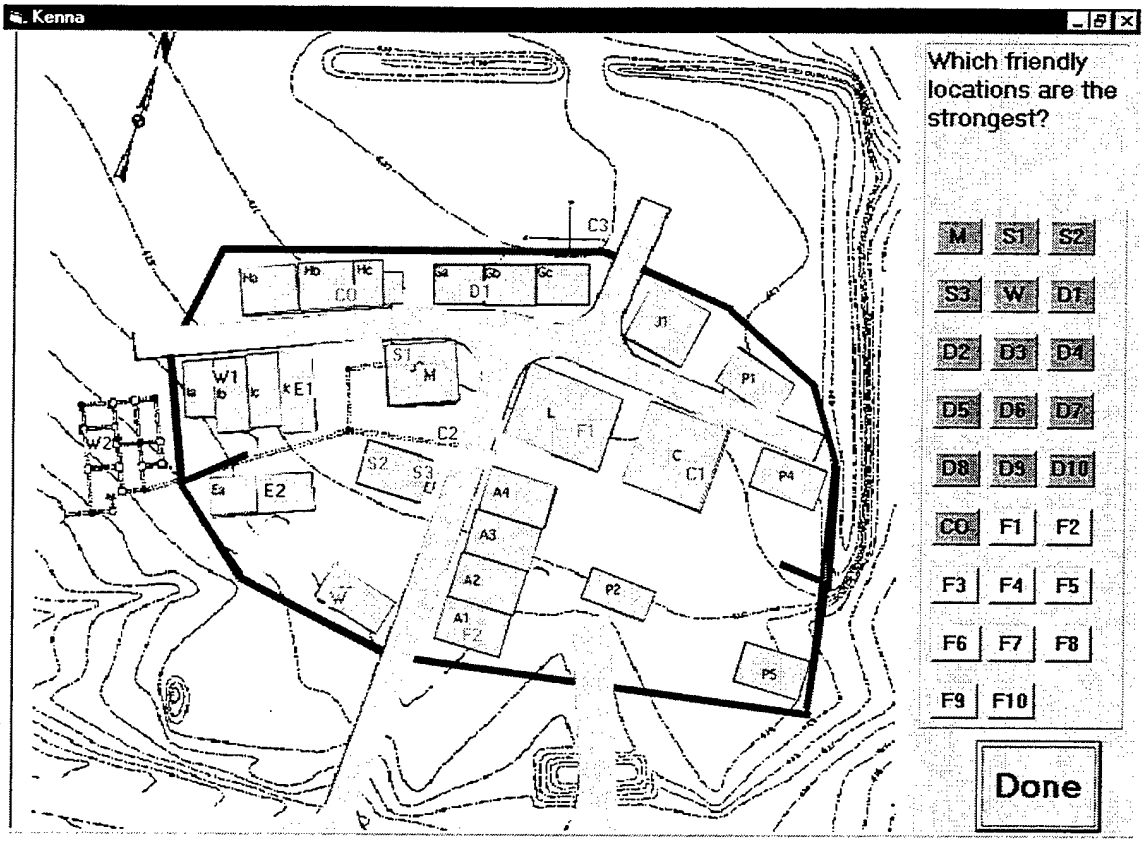
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the enemy units with the strongest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

6



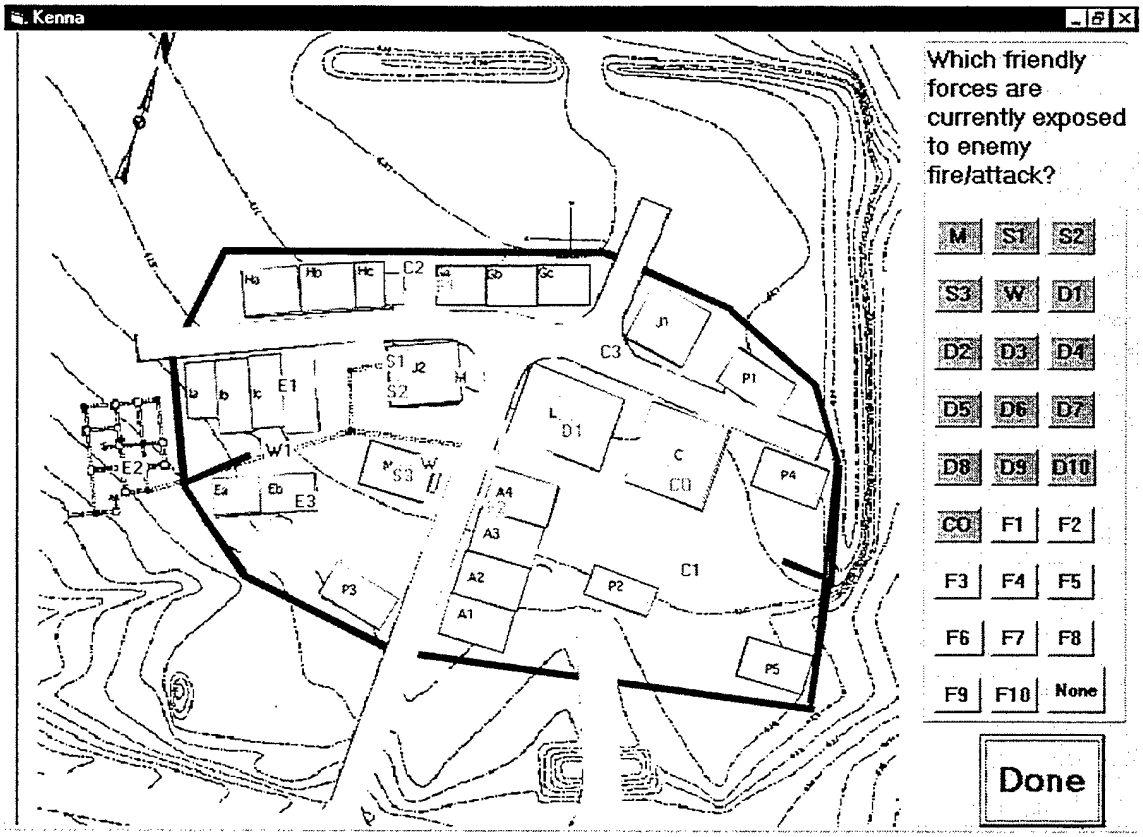
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units with the weakest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

7



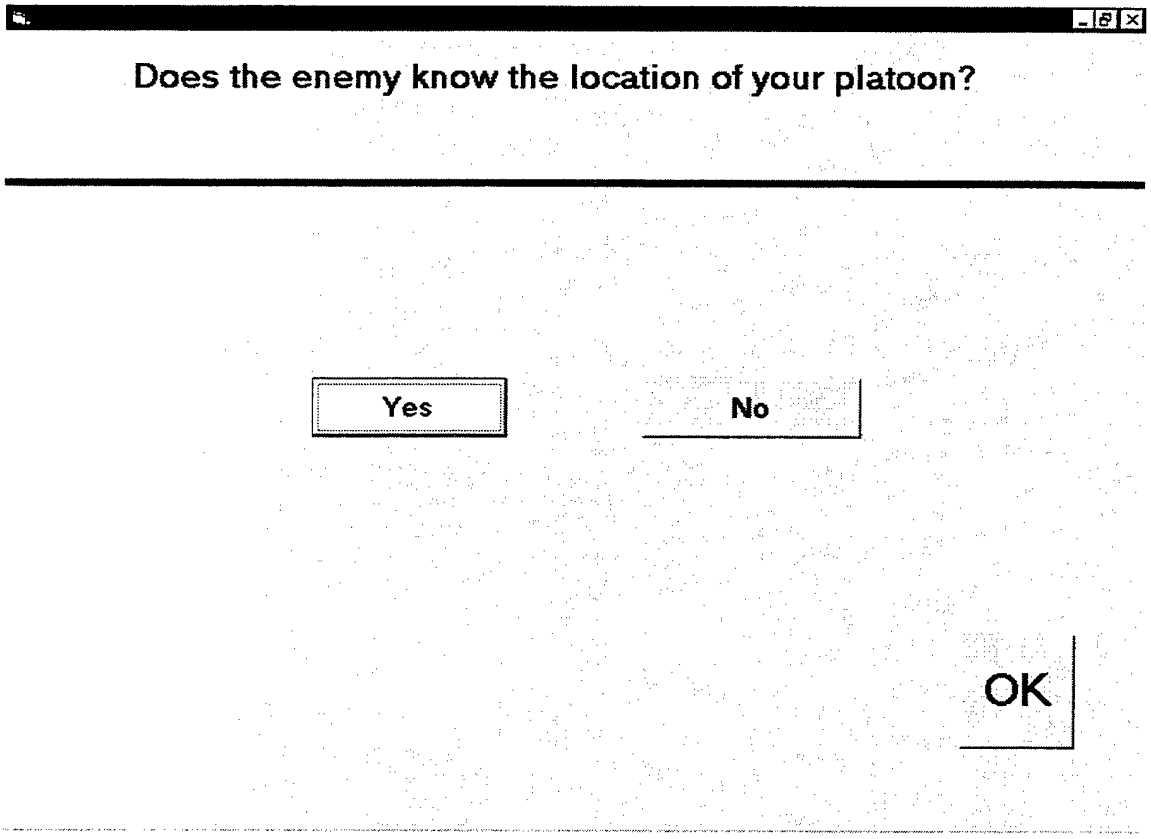
The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units with the strongest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

9



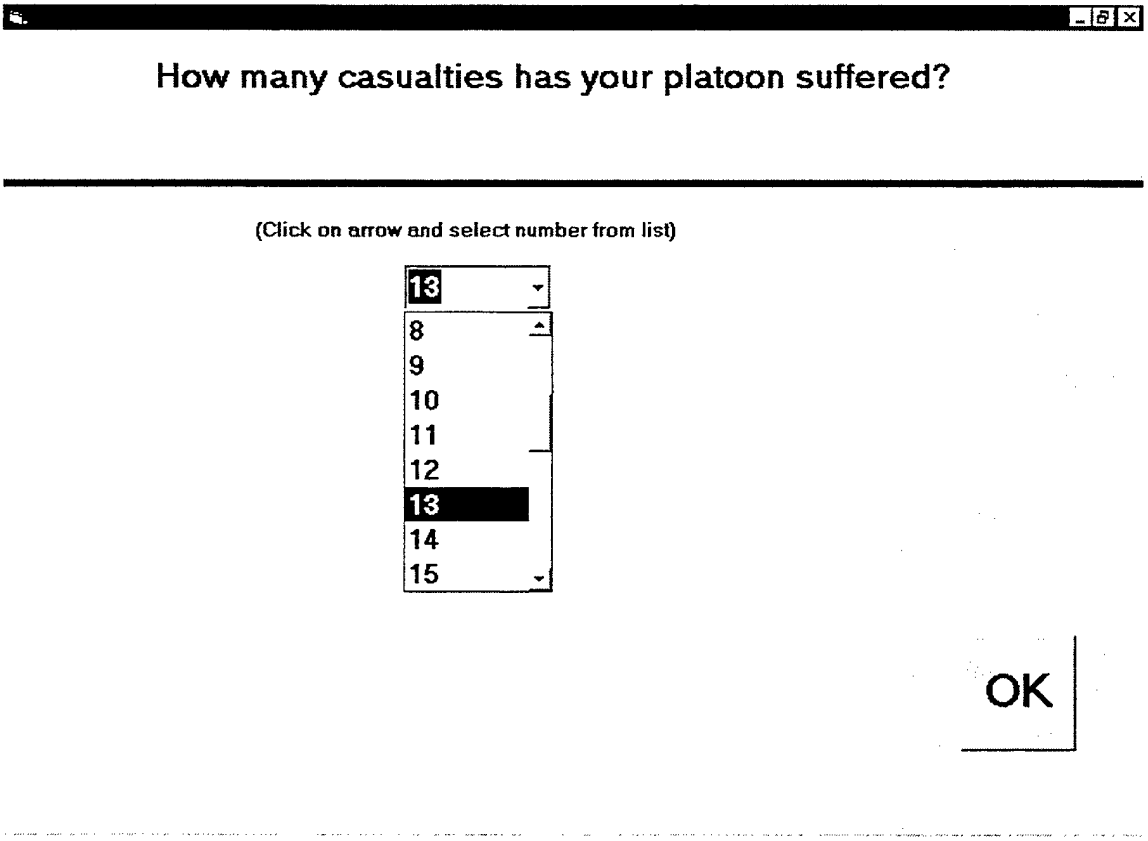
The locations of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units who are currently exposed to enemy fire/attack. You may indicate more than one. Click on the Done button when finished.

12



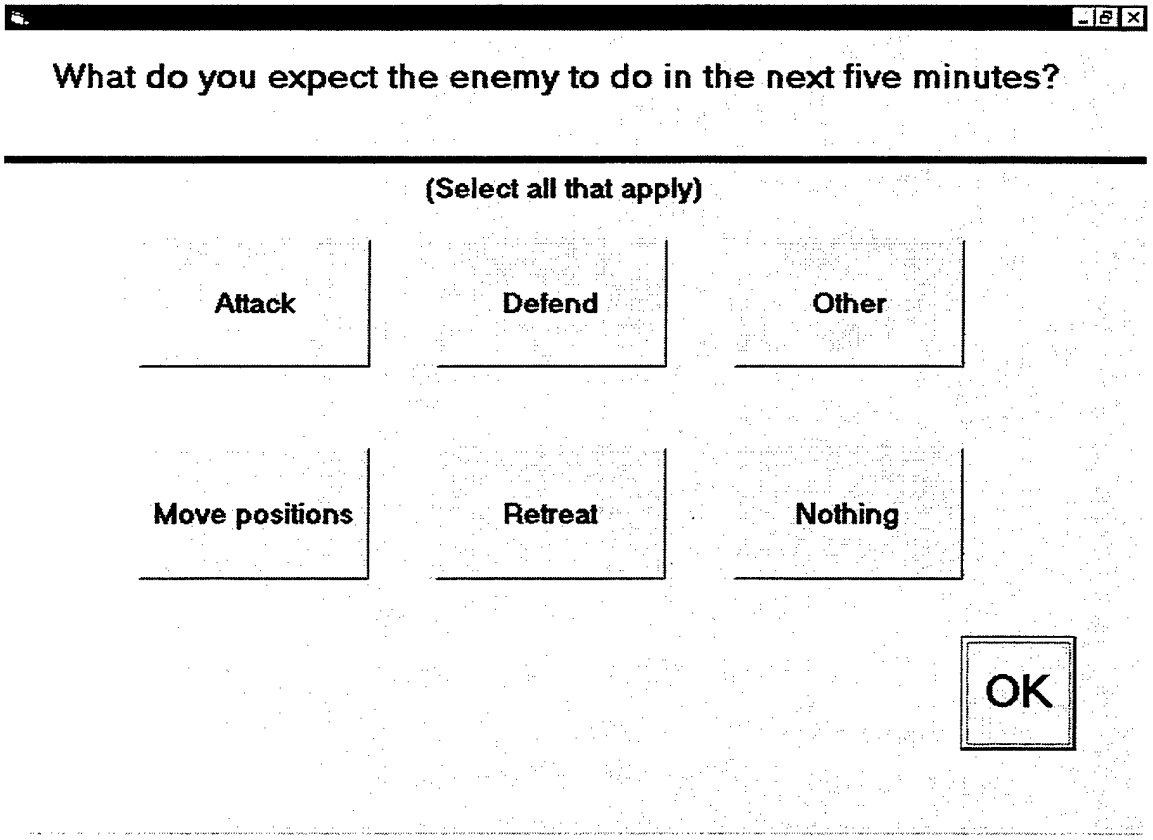
Indicate whether any enemy troops currently are aware of your location or that of any of your platoon. Click on the OK button when you are done.

16



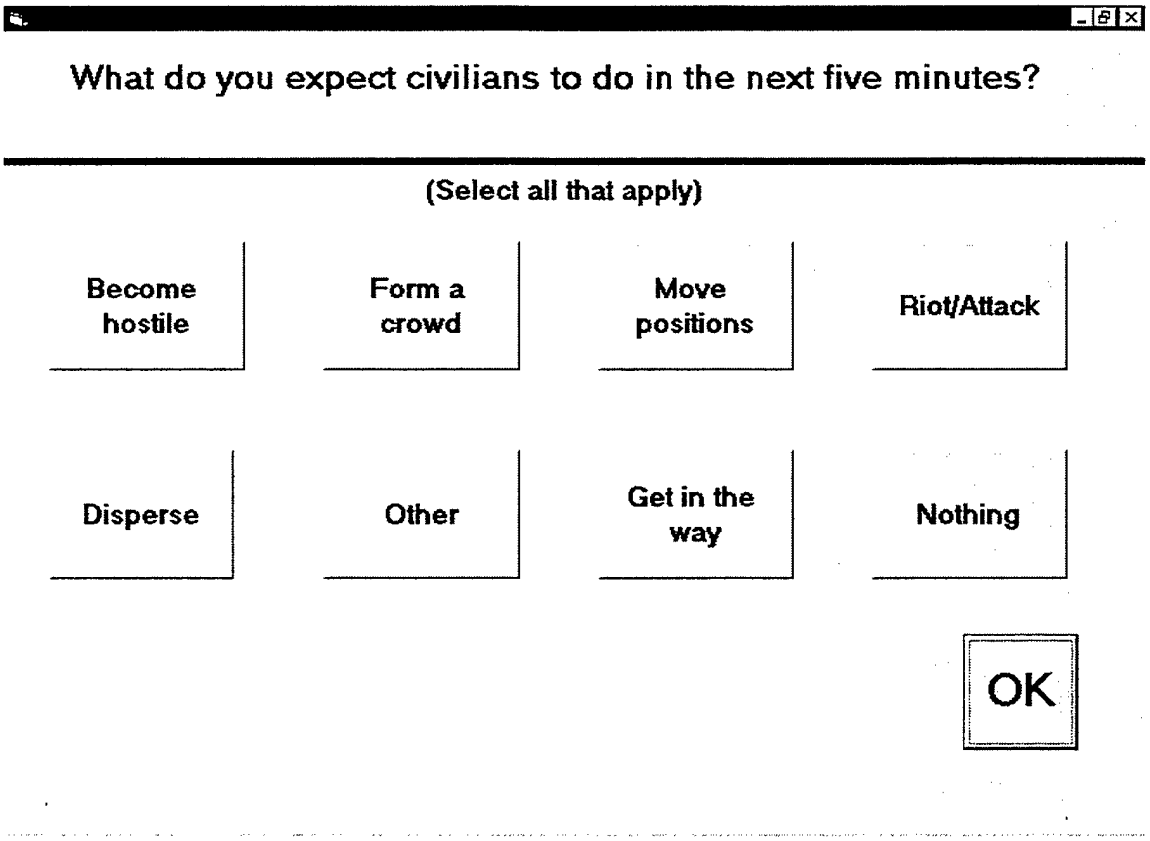
Indicate how many casualties your platoon has suffered up to this point by using the pull down menu. Click on the OK button when you are done.

17



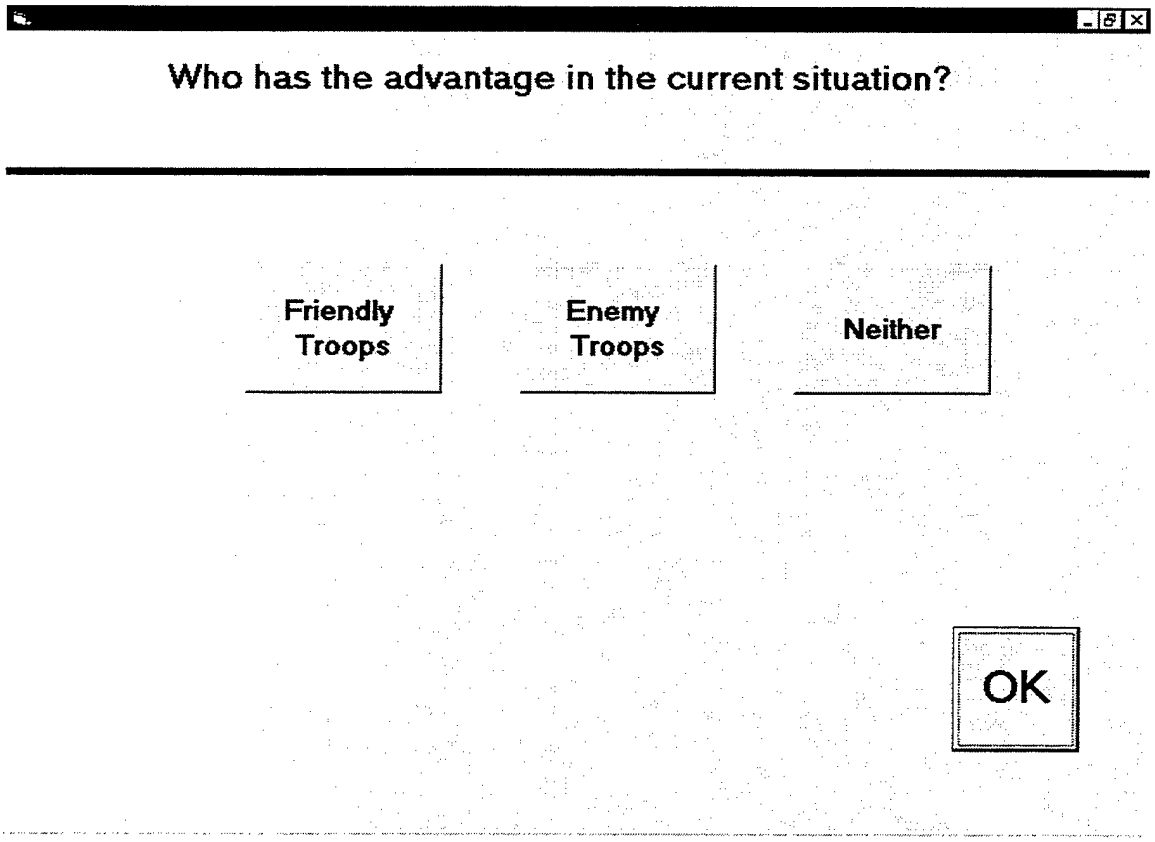
Indicate what actions you expect the enemy troops in this scenario to take in the next five minutes. Click on the OK button when you are done.

18



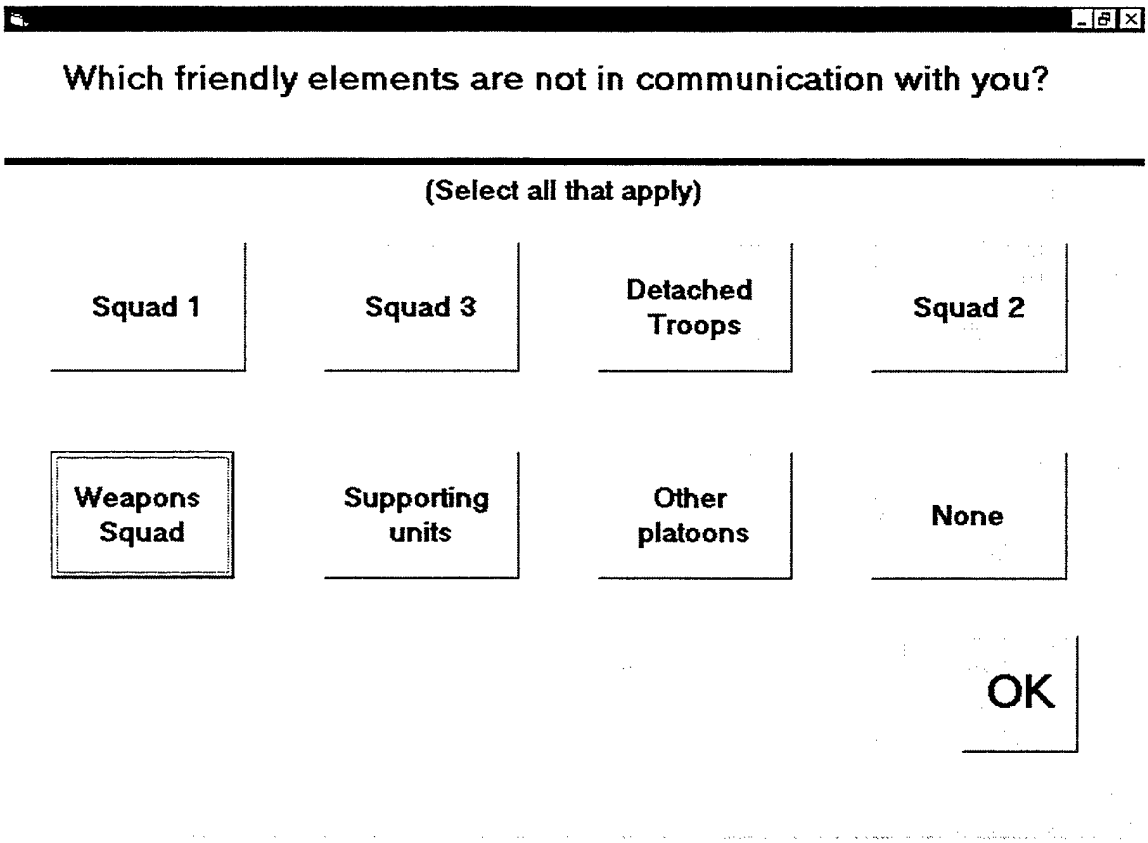
Indicate what actions you expect the civilians in this scenario to take in the next five minutes. Click on the OK button when you are done.

19



Indicate whether friendly or enemy troops (or neither) currently have the advantage by clicking on the appropriate button. Click on the OK button when you are done.

21
1



Indicate whether any of the above friendly troops have lost communications with you. If all are in communication with you, click on the None button. Click on the OK button when you are done.

SAGAT
(Paper-and-pencil version for company commander)

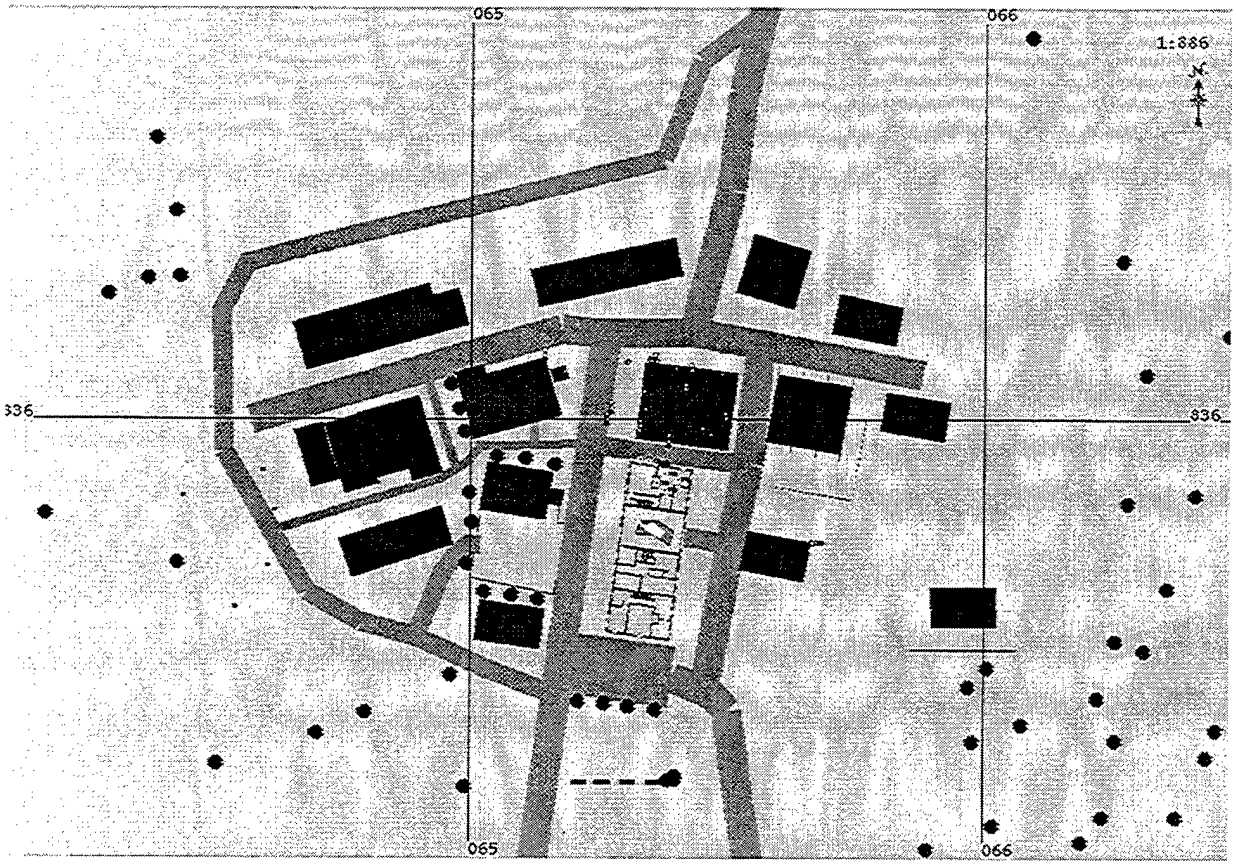
Participant_____ Scenario_____ Stop Number_____

SAGAT – Expert Rating Form

Based on having perfect knowledge of the situation:

2. Indicate the highest level threat (to the participant) with an X
4. Indicate the weakest enemy locations with a O
5. Indicate the strongest enemy locations with a S

ENEMY INFORMATION

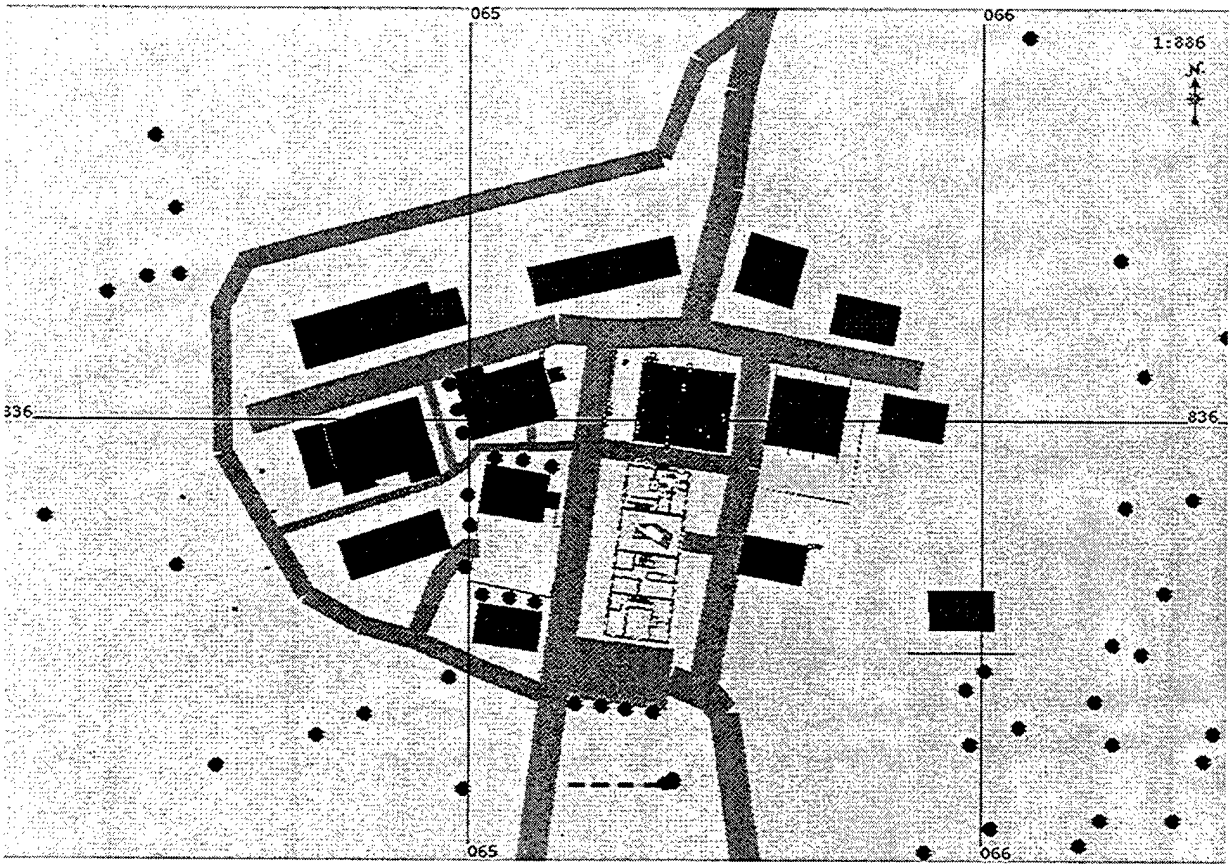


Note. Buildings in actual map used by company commander are white and labeled. Original map drawing did not replicate clearly. This is an actual slide of the McKenna area where scenarios were executed.

Based on having perfect knowledge of the situation:

6. Indicate the weakest friendly locations with a O.
7. Indicate the strongest friendly positions with a S.
9. Indicate which friendly positions are exposed to enemy fire/attack with an F
14. Indicate where there are troops in locations that do NOT offer concealment with a NC.
15. Indicate where there are troops in locations that do NOT offer cover with a NV.

FRIENDLY INFORMATION



Note. Buildings in actual map used by company commander are white and labeled. Original map drawing did not replicate clearly. This is an actual slide of the McKenna area where scenarios were executed.

Based on having perfect knowledge of the situation:

3. Can all assigned squad tasks be accomplished within the time requirements?
   YES NO

12. Does the enemy know where the friendly platoon is at?
    YES NO

16. How many casualties have the friendlies suffered? _____

17. What do you expect the enemy to do in the next 5 minutes?

    - Attack
    - Nothing
    - Move positions
    - Defend
    - Retreat
    - Other

18. What do you expect civilians to do in the next 5 minutes?

    - Become hostile
    - Riot/attack
    - Form a crowd
    - Disperse
    - Nothing
    - Move positions
    - Get in the way
    - Other

19. Who has the advantage in the current situation?

    - Friendly troops
    - Enemy troops
    - Friendly and enemy troops equal

20. For which friendly element are plans not being executed as per orders?

    - Squad 1
    - Squad 2
    - Squad 3
    - Weapons squad
    - Other platoons
    - Supporting units
    - None

21. Which friendly elements are not in communication with the platoon leader?

    - Squad 1
    - Squad 2
    - Squad 3
    - Weapons squad
    - Other platoons
    - Supporting units
    - None

Appendix J

Post Trial Participant Subjective SA Questionnaire

Participant _____

Scenario_____

Date _____

1. Please circle the number below that best describes **how hard you were working** during this scenario.	not hard	1	2	3	4	5	extremely hard
Comments: _____							

2. Please circle the number that best describes **how well you performed** during this scenario	Extremely poor	1	2	3	4	5	extremely well
Comments: _____							

3. Please circle the number that best describes **how aware of the evolving situation you were during the scenario**.	Not aware of situation	1	2	3	4	5	Completely aware of situation
Comments: _____							

Appendix K

Post Experiment Questionnaire

Name_____ Date_____

1. Rate the training value of each scenario listed below.

(Use the following scale: 1=No training value; 2=Some training value; 3=Moderate training value; 4=Significant training value).

_____Defend town
_____Company assault
_____SASO civil disturbance
_____Secure village/Downed aircraft

Briefly explain your ratings.

2. How challenging did you find each of the scenarios listed below.

(Use the following scale: 1=Not very challenging; 2=Reasonably challenging; 3=Very challenging; 4=Too difficult).

_____Defend town
_____Company assault
_____SASO civil disturbance
_____Secure village/Downed aircraft

Briefly explain your ratings.

3. What did you like most about the training?

4. What did you like least about the training?

5. Based on your experiences today, what suggestions do you have for making this type of training more effective?

6. Do you feel that your decision-making skills improved as a result of the training you received?

_____Yes _____No

Briefly explain your answer.

7. Do you think that decision-making skills can be effectively taught using virtual environment technologies?

_____Yes _____No

Briefly explain your answer.

8. Would you like to see some form of virtual environment decision-skills training included in the IOBC curriculum?

_____Yes _____No

Briefly explain your answer.

Appendix L

Scenario A: SASO-Civil Disturbance

1. Co A, 1-11th Infantry is in the first day of occupying the town of Kenna. The company has the mission to defend the town. The enemy presence is considered light, capable of conducting military operations in the immediate region with insurgent forces less than platoon-size, possibly supported by mortars. There is no heavy threat. Last reported enemy activity in the region was a terrorist bombing conducted in the neighboring town of Polo, 3 kilometers to the northwest, 3 days ago. The town population of Kenna is considered to be overall friendly. However, there may be insurgents and insurgent sympathizers within the town's population.

2. The company has established defensive positions with 1st and 3d Platoons defending the town from selected positions in buildings along the perimeter of the town. 1st Platoon is in the east. 3d Platoon is in the west. Your platoon, the 2d Platoon, is to establish 1 squad-sized roving patrol within the town. Your other 2 squads are held as the company reserve. The company commander selected the north side of BLDG A4 as your platoon CP location. He has directed that all platoon leaders remain in the general vicinity of their respective CPs for communications purposes. He has directed that the platoons use their platoon sergeants as much as possible to realign positions, if necessary. The company CP is in the north side of BLDG N.

3. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have cross-attached the Weapons Squad to the 3 line squads.

4. The 2d Platoon has been in position for 6 hours. 1st Squad is currently positioned in BLDG Eb, and 2d and 3d Squads are located in BLDG L.

5. The company executive officer is injured and is currently seeking emergency medical treatment. He is expected back later today. You are the senior platoon leader.

6. Ration cycle is C, C, T. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.

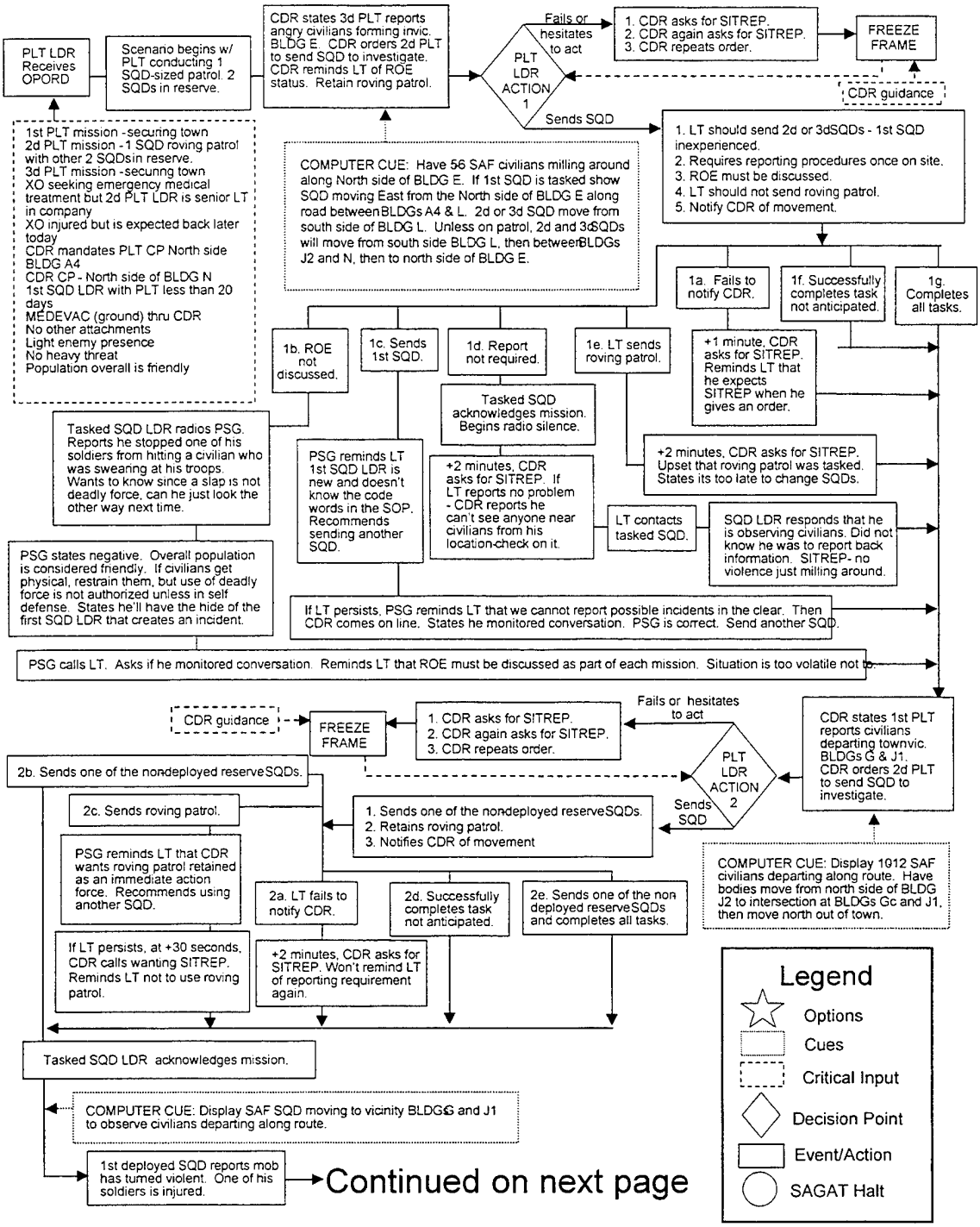
7. Rules of Engagement (ROE). Since the overall town population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except in self-defense or in defense of the town against a confirmed enemy presence. Self-defense is defined as a serious threat to life or limb. A serious threat is considered gunfire or the presence of an uncontrolled mob armed with life-threatening weapons such as knives, pikes, metal poles, etc. Every effort must be made to disarm the situation prior to the use of deadly force. Weapons control status is white.

8. Your immediate task is to select a squad to conduct the roving patrol and brief your squad leaders.

9. What are your questions?

10. The scenario will begin once you have briefed your platoon, the squad-sized roving patrol is preparing to deploy, and you have occupied your CP location.

Scenario A: SASO-Civil Disturbance, 2d PLT Mission



Scenario A: SASO-Civil Disturbance, 2d PLT Mission (Continued)

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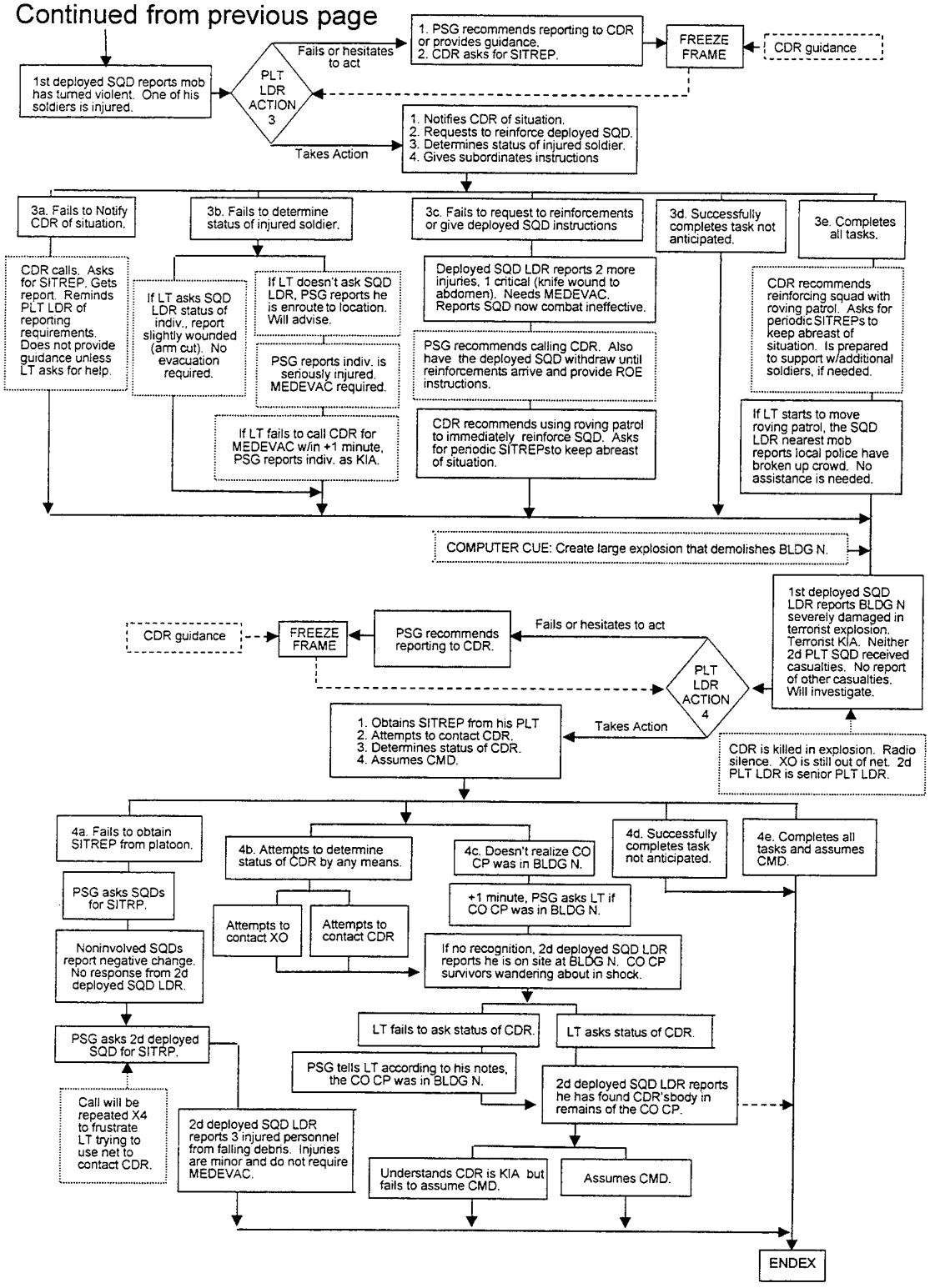


Appendix M

Scenario B: Company Assault

1. Co A, 1-11th Infantry is conducting a company assault on the town of Kenna. The company is attacking the town from north to south. The initial assault was successful. The 1st Platoon attacked the H-series buildings and has successfully cleared BLDGs J2 and the I-series buildings. They are currently in the I-series building preparing to assault the E-series buildings. Their follow-on objectives are BLDGs N and P3. The 3d Platoon successfully attacked and cleared BLDGs P1, P4, and C. They are currently in BLDG C, preparing to attack BLDG P2. Their follow-on objective is BLDG P5.

2. The 2d Platoon, your platoon, is in the center. Your platoon has successfully cleared the G-series buildings and is currently located in BLDG L. You are at 100% strength. You are preparing to assault BLDGs A4 then A3, A2, and A1 respectively. The commander has directed you to observe the assault from a vantage point from the 2d floor of BLDG L. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have attached the Weapons Squad to the 3 line squads. There are no other attachments to the platoon.

3. The enemy is expected to provide stiff resistance as he withdraws his forces to follow-on positions to the southern part of town. The enemy is estimated at platoon strength. He has mortars, but has not yet employed them. He is fighting from well-fortified, prepared positions.

4. Ration cycle is C, C, T. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.

5. Rules of Engagement (ROE). Since the local civilian population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except against confirmed enemy

locations. Targets must be clearly identified as hostile. Every effort must be made to avoid civilian casualties. Explosives cannot be used without permission of the company commander. Weapons control status is yellow.

6. Your immediate task is to plan the assault on BLDG A4 and brief your squad leaders.

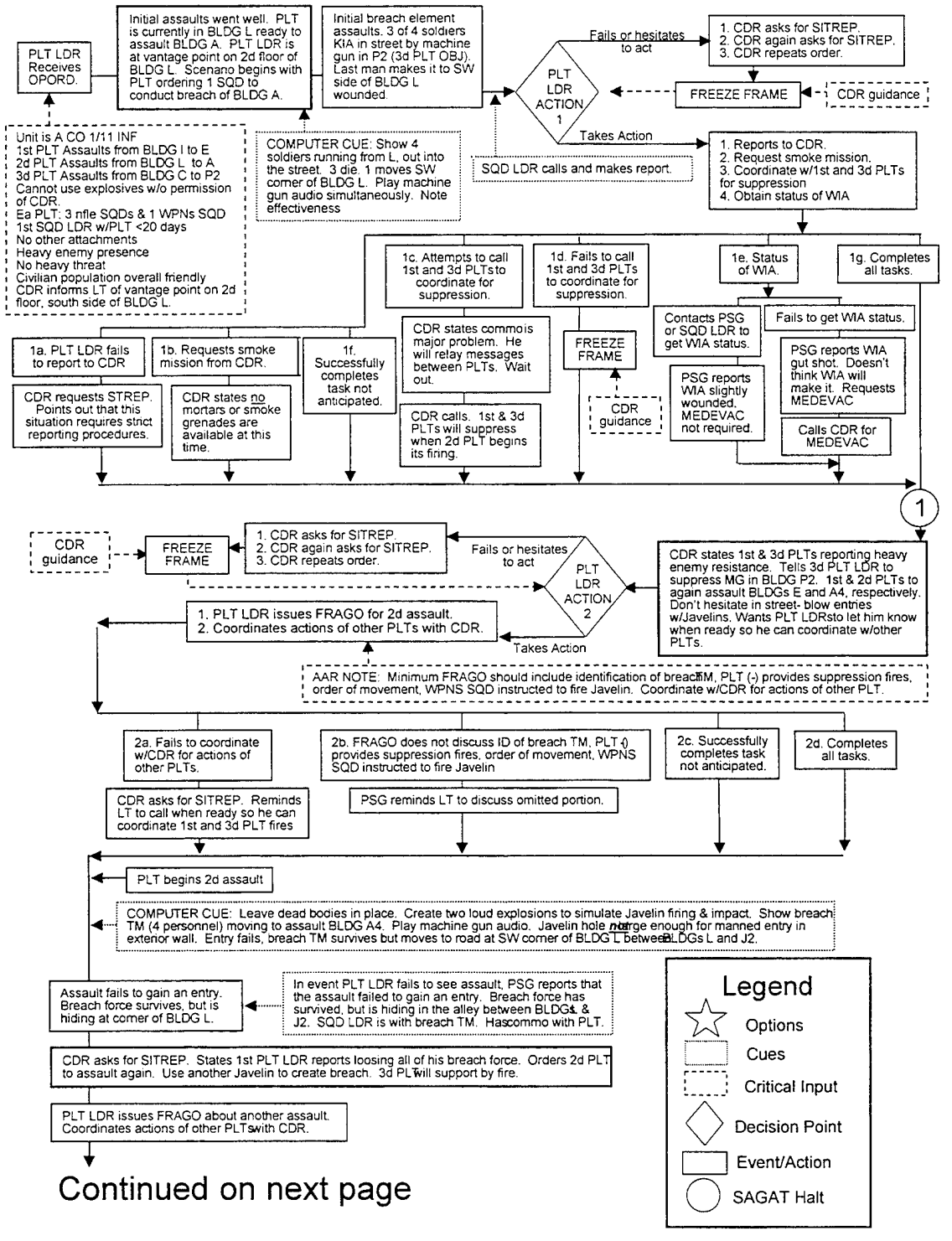
7. What are your questions?

8. The scenario will begin when you occupy the vantage point in BLDG L.

Scenario B: Company Assault 2d PLT Mission from BLDG L to A4

AS OF 6 Jul 2000

SET-UP
1. Enemy machine gun in NE corner of BLDG P2 orientated NW to N.
2. Need 1 small hole blown in N side of BLDG A4 (see computer cue).
3. Need second hole blown adjacent to 1st hole. The combination of the two will make a hole large enough for soldiers to enter the BLDG (see computer cue).
4. Need machine gun audio 2 times (see computer cue and scenario for effectiveness).
5. Need 4 dead civilians in BLDG A4 w/marked chemical containers located on the floor, in adjacent room to the (entry point). Need abandoned enemy tank in beside the east side of BLDG A4.



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Scenario B: Company Assault 2d PLT Mission from BLDG L to A4

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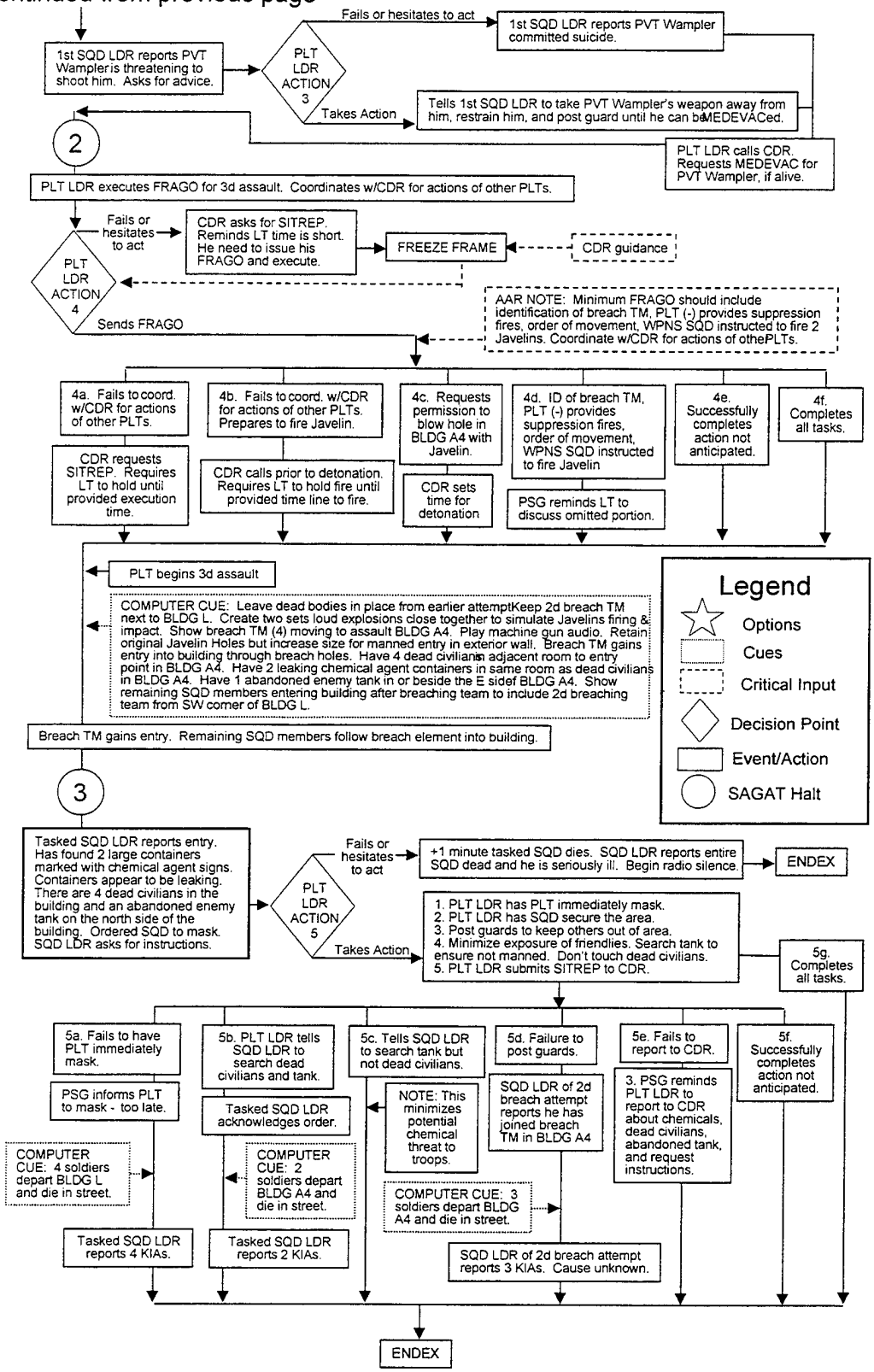


Appendix N

Scenario C: Defend Town

1. Co A, 1-11th Infantry is in the first day of occupying the town of Kenna. The company has the mission to defend the town. The enemy presence is considered light, capable of conducting military operations in the immediate region with forces less than company-size, supported by mortars. There is no heavy threat. Last reported enemy activity in the region was a platoon-sized raid conducted in the neighboring town of Polo, 3 kilometers to the northwest, 2 nights ago. The town population of Kenna is considered to be friendly. However, there may be insurgents and insurgent sympathizers within the town's population.

2. The company has established a defensive perimeter with 1st Platoon defending in the southeast quadrant of the town from BLDGs P5, P2, and A1. Your platoon, the 2d Platoon, defends the southwest quadrant of the town from BLDGs Ia-Id, Ea, and P3. 3d PLT defends the northwest quadrant from BLDGs H, G, and J1. Company A Mortars defends the northeast quadrant from BLDGs P1 and P4. The company CP is located in the north side BLDG A4.

3. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have attached the Weapons Squad to the 3d Squad to take advantage of the height of Building Id. There are no attachments to the platoon.

4. The 2d Platoon has been in position for 6 hours. The squads are positioned as shown in the accompanying graphic. The company commander selected the north side of BLDG P3 for the 2d Platoon CP. He has directed that all platoon leaders remain in the general vicinity of their respective CPs for communications purposes. He has directed that the platoons use their platoon sergeants as much as possible to realign positions, if necessary.

5. Ration cycle is C, C, A. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured

enemy personnel or civilian detainees will be handled through company channels.

6. Rules of Engagement (ROE). Since the overall town population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except in self-defense or in defense of the town against a confirmed enemy presence. Self-defense is defined as a serious threat to life or limb. A serious threat is considered gunfire or the presence of an uncontrolled mob armed with life-threatening weapons such as knives, pikes, metal poles, etc. Every effort must be made to disarm the situation prior to the use of deadly force. Weapons control status is white.

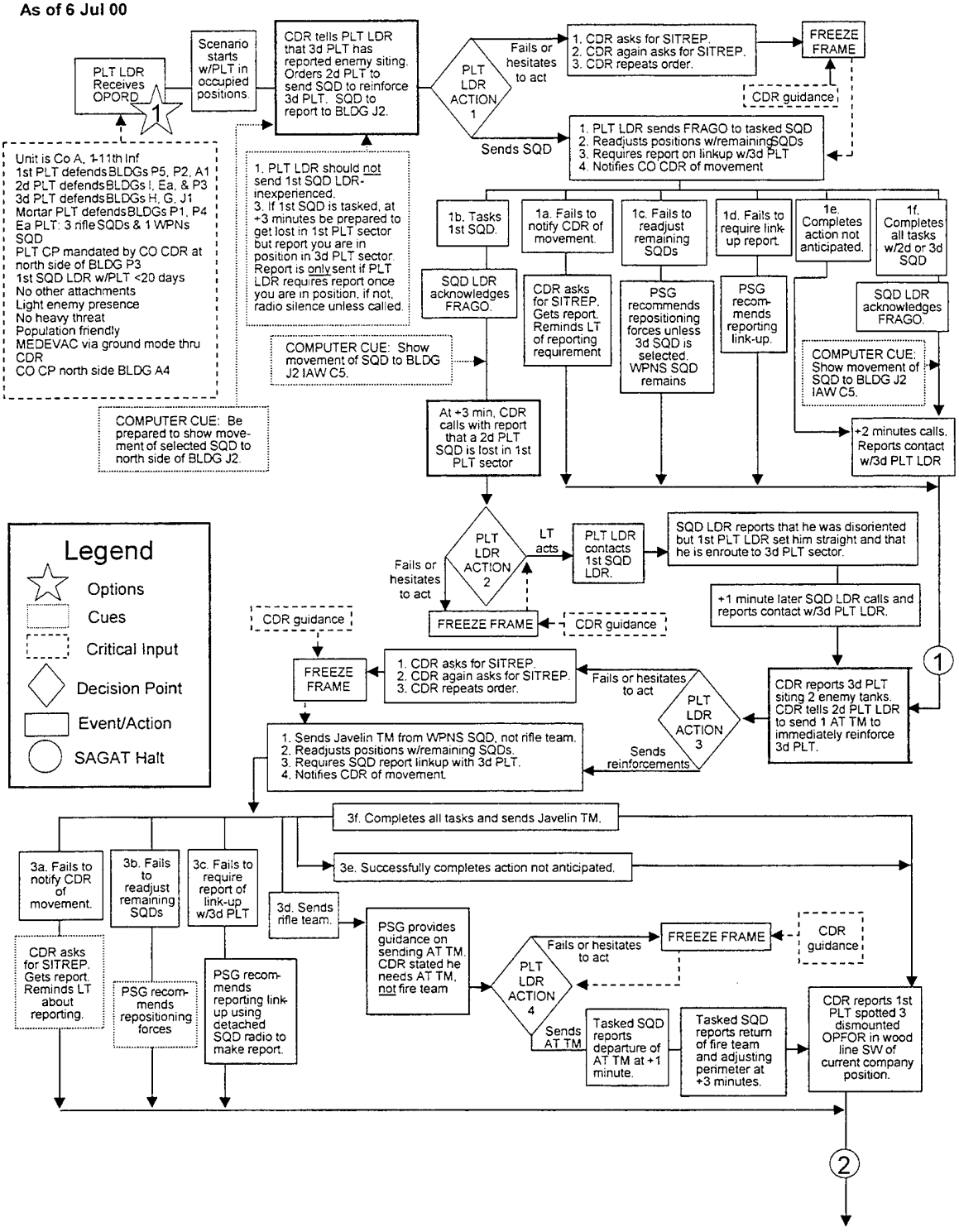
7. Your immediate task is to brief your squad leaders as to the current situation.

8. What are your questions?

8. The scenario will begin when you have returned to your CP location and receive a radio transmission from the company commander.

Scenario C: Defend Town, 2d PLT Mission

As of 6 Jul 00



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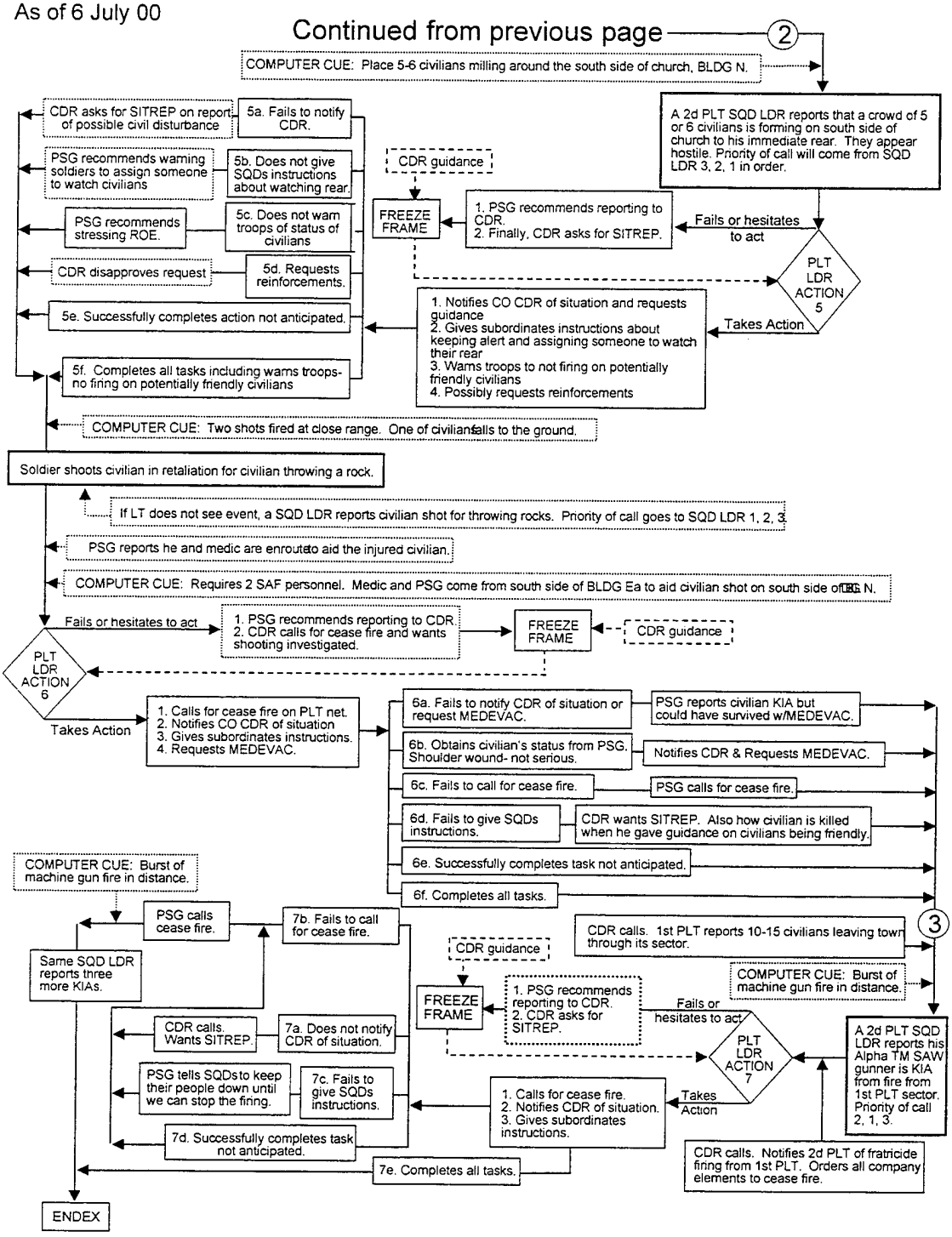
Scenario C: Defend Town, 2d PLT Mission (Continued)

As of 6 July 00



Appendix O

Scenario D: Secure Village; React to Downed Aircraft

1. Co A, 1-11th Infantry is conducting platoon-sized defenses of 3 villages. The commander is located in the village of Polo. He has directed that the platoons establish and maintain checkpoints in each of the villages. Each platoon is to employ a roving patrol for additional security, as needed. 1st Platoon is securing the village of Polo, 3 kilometers to the northeast. 3d Platoon is securing the village of Tuskin, 3 kilometers to your south. Company C, 1-11th Infantry is the battalion reaction force.

2. The 2d Platoon, your platoon, is securing the village of Kenna. The town population of Kenna is considered to be friendly. However, there may be insurgents and insurgent sympathizers within the town's population. To secure Kenna, you have established two checkpoints. 1st Squad is at Checkpoint North, located at the road intersection between BLDGs Gc and J1. 2d Squad is at Checkpoint South, located due south of BLDG A4. Both checkpoints block the major route into the village. The 3d Squad is collocated with the platoon CP in BLDG C, the jail. 3d Squad is preparing to conduct a roving patrol of the village. The Weapons Squad has been detached to the village of Polo to train local police on the use of heavy weapons. There are no other attachments to the platoon.

3. The enemy presence is considered light, capable of conducting military operations in the immediate region with forces less than platoon-size, supported by mortars. There is no heavy threat. Last reported enemy activity in the region was a platoon-sized raid conducted in the neighboring town of Polo, 3 kilometers to the northwest, 2 nights ago.

4. Ration cycle is C, C, T. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.

5. Rules of Engagement (ROE). Since the overall town population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except against confirmed enemy

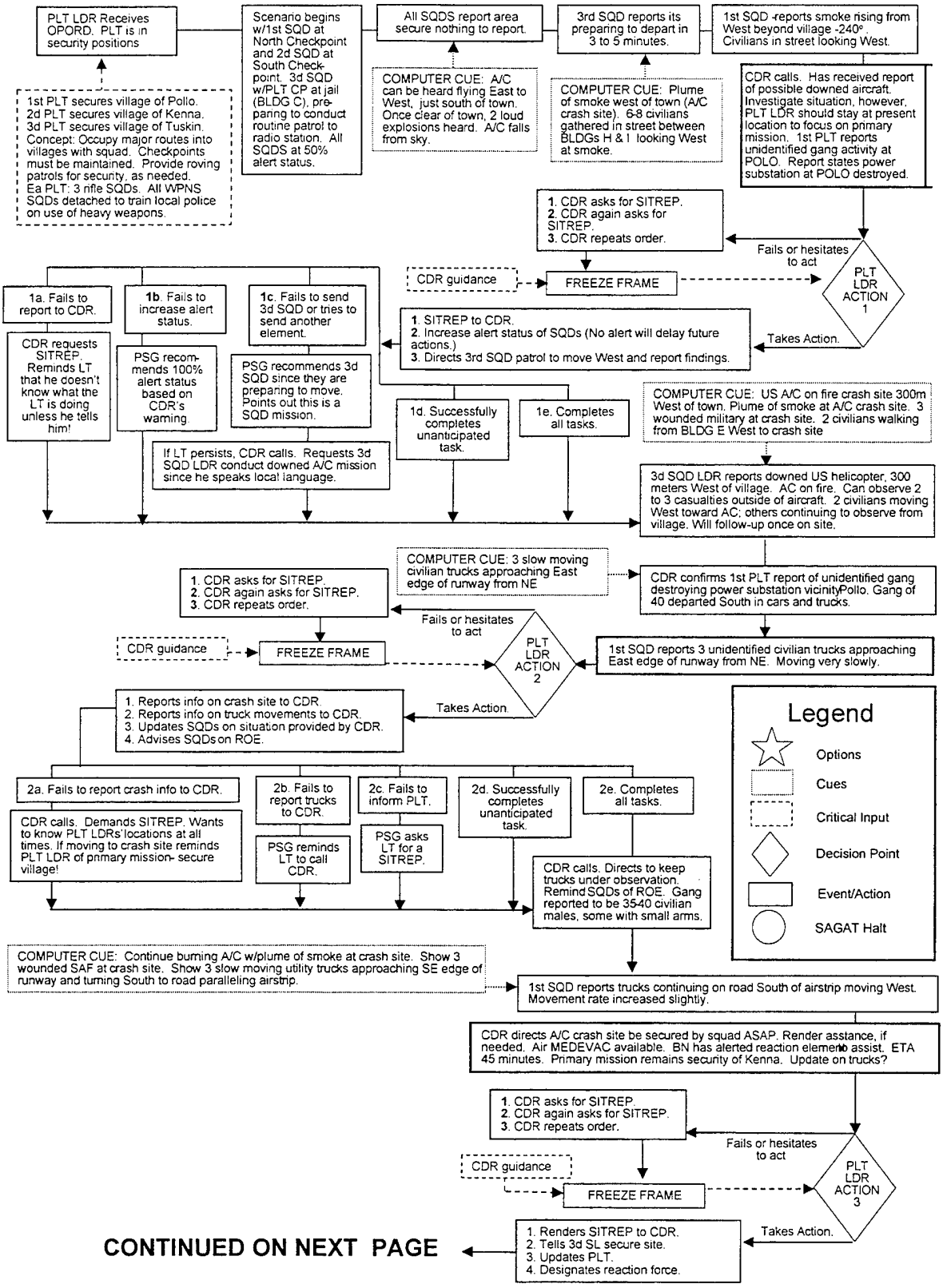
locations. Targets must be clearly identified as hostile. Every effort must be made to reduce or eliminate civilian casualties. Weapons control status is white.

6. Your immediate task is to brief your squad leaders on the current situation.

7. What are your questions?

8. The scenario will begin when you occupy the platoon CP in BLDG C.

Scenario D: Secure Village; React to Downed Aircraft



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Scenario D: Secure Village; React to Down Aircraft

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